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Vol. XVII. MAY, 1922. Part 1.

Transactions of the Mining and Geological Institute of India.

Edited by
The Honorary Treasurer.

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Transactions
of the
Mining and Geological Institute of India.

Part 1.] 1922. [August.

Annual General Meeting.

Calcutta, 27th January, 1922.

The sixteenth Annual Meeting of the Mining and Geological Institute of India was held in the Asiatic Society's Hall, Calcutta, on January 27, 1922.

Present:—Messrs. H. S. Allen, J. Bullock, J. Brown, C. B. Chartres, N. G. Chatterji, Geo. Crawford, Dr. L. L. Fermor, Messrs. B. Heaton, Alec. B. Hughes, A. Ghose, Jhaverilal Kalyanray, L. S. Dholakia, G. W. Marshall, E. D. McDermott, J. Miller, K. Mirza, N. N. Mukherjee, J. A. Oliver, E. Parsons, D. Penman, R. Purdy, E. H. Roberton, F. L. G. Simpson, R. R. Simpson, H. M. Tarlton, J. Thomas, D. D. Thacker Dr. G. W. Thompson, Messrs. G. H. Tipper, J. B. Wardlaw and G. C. Webster—*Members.*

Messrs. Jadulal K. Dholakia, Jugatram Nagar and S. K. Mukherjee —*Visitors.*

Prior to the annual meeting an Extraordinary General Meeting of the Institute was held, Mr. G. Miller (President) presiding.

The Honorary Secretary (Mr. E. H. Roberton) read the notice convening the meeting, which was called for the purpose of passing the following proposed new rule:—

> On retirement from India any Ordinary Member, or Subscriber (not being a corporate body) who has not already compounded for his annual subscription. as also any Associate Member or Associate, may, provided he has already paid not less than seven annual subscriptions, compound for all future subscriptions on payment of Rs. 50; provided that should such Ordinary Member, Subscriber Associate Member, or Associate, return at any time to India, he shall pay half the annual subscription of his class of membership for each half calendar year, or portion thereof, during which he remains in India, the half years dating from January 1st and July 1st of each year.
>
> Members who have resigned prior to January 1st, 1922, shall with the sanction of the Council be permitted to take advantage of this rule at any date up to December 31st, 1922.

The President: Well, gentlemen, you have heard the proposal that the Council have to make with regard to the introduction of this new rule. Slips were sent to members asking for their views with regard to this and 47 slips were returned in favour. I may explain that it is hoped that members who would otherwise resign from the Institute altogether on retirement to England may, by the introduction of this rule, maintain their connection with the Institute, and we hope to keep them interested, and to get them to write papers from home on mining conditions there. They have probably more time on their hands at home, and it may be possible to keep them interested in such a way as to continue to write on home conditions. We think this would be very beneficial to the Institute members. They would get the latest facts with regard to mining operations sent out from men who are in the thick of it. I will ask Dr. Fermor to propose this rule.

Dr. Fermor: I don't think there is anything more to add. I propose that the new rule as embodied in the notice circulated to members and read out by the Honorary Secretary be passed.

Mr. R. R. Simpson : I second that, Mr. President.

The resolution was then passed unanimously

The President : That closes the business of the Extraordinary General Meeting. We now proceed with the business of the Annual General Meeting.

Messrs. J. A. Oliver and A. B. Hughes were appointed scrutineers in connection with the election of officers.

The Honorary Secretary then read the minutes of the last annual meeting held on February 14th, 1921, which were confirmed.

The draft report of the Council for the past year was then presented as follows :—

REPORT OF COUNCIL.

The Council have the honour to present the sixteenth Annual Report on the working of the Mining and Geological Institute of India.

2. The total number of members at the close of the year was 320 as against 302 at the close of the previous year. The additions to the register and the losses by resignation, death, etc., for the past five years are shown in the following table :—

	1917	1918	1919	1920	1921
Additions ..	9	27	25	33	41
Losses ..	13	6	20	14	23
Gain ..	..	21	5	19	18
Loss ..	4	..	..	..	..

The following is an abstract of the membership of the Institute :—

	1917	1918	1919	1920	1921
Ordinary Members..	201	205	202	201	222
Associate ,, ..	13	30	39	53	51
Associates ..	5	5	5	9	10
Honorary Members	12	12	11	12	11
Subscribers ..	26	26	26	27	26
TOTAL ..	257	278	283	302	320

From the above it will be seen that during the past year there has been a distinct increase in the number of Ordinary Members. The number of Ordinary Members elected was 40, but as four have so far failed to pay their fees, the actual number admitted is 36. Further, one member elected in 1920, has paid his fee during the year, making a total of 37 Ordinary Members added to the last list. On the other hand, four have resigned, four have died and eight have been struck off under Rule 14. The number of Associate Members who joined was five out of seven elected. One has withdrawn his application, and the other has not yet paid his entrance fee. Against this, two have died and two have been struck off. The names of Messrs. D. P. Davies, M. C. Raisurana and E. S. Tarlton have been transferred from the list of Associate Members to that of Ordinary Members. Two Associates joined during the year and one resigned. There has been a diminution of one in the number of Honorary Members and one in that of subscribers.

3. The following members joined during the year :—

Names.	Qualifications.
1. Allan, John Donaldson Blair ..	Mining Engineer, Holder of 1st Class Mine Managers' Certificate under British Mines Act. Simlabahal Colliery, Jharia, Manbhum.

	Names.	Qualifications.
2.	Anderson, David A. ..	Agents for Messrs. Andrew Yule and Co.'s Jharia Collieries, M.I.M.E., Bhuggutdih, Jharia.
3.	Bartlett, Leslie Hugh ..	Mining Engineer, A.R.S.M., M.I.M.E., Bharweli P.O., Balaghat, C.P.
4	Barrowman, Alexander ..	Mining Engineer, Holder of 1st. Class Mine Managers' Certificate. Hurriladih Colliery, Jharia, Manbhum.
5.	Bell, John Valentine ..	Colliery Manager, Searsole Colliery, Raniganj, E.I.R.
6.	Bell, William Richards ..	Chemical Engineer, Post Box 93, Kusunda, Jharia.
7.	Bennetts, William Henry ..	Mining Engineer, 1st Class Diploma at Camborne School of Mines. P.O. Dongree, via Tumsar Road, B.N.R., C.P.
8.	Berry, William Henry ..	Mechanical and Mining Engineer, Kotamba Bungalow, Ramakona P.O., Chindwara, C.P.
9	Boga, Feroze D. ..	Colliery Proprietor, Kusunda, Manbhum.
10	Bose, Bhupendra Kumar ..	Colliery Manager. Holder of 1st Class Mine Managers' Certificate. General Manager, Messrs. R. B. Sarcar and Sons, Kusunda P.O., Manbhum.
11.	Clark, William Henry ..	Mine Manager, Takli Road, Nagpur.
12.	Clegg, Edward Leslie Gilbert ..	Asst. Superintendent, Geological Survey of India, B.Sc. (Manch.), Calcutta.
13.	Farquhar, Andrew ..	Mining Engineer, Sudamdih, Pathardih P.O., Jharia.
14.	Foster, John ..	Mining Engineer and Surveyor; Holder of 1st Class Mine Mana-

Names.	Qualifications.
	gers' Certificate. Manager of Katras Colliery, P.O. Box 252, Katrashgarh, E.I.R.
15. Fullwood, Joshua Henry ..	Acting Colliery Superintendent, E.I. Ry. Collieries, Giridih, Holder of 1st Class Mine Managers' Certificate of Competency under British Mines Act. Giridih, E.I.R.
16. Gwyn-Williams, R. Henry	Mining Engineer, The Indian Manganese Co., Ld., Balaghat, C.P.
17. Harris, Charles Stanley ..	Mining Engineer, A.I.M.M., Ukua P.O., Balaghat, C.P.
18. Harvey, Robert ..	Mining Engineer, Camborne School of Mines, 1st Class Diploma, 59 The “Hive,” Kamptee, C.P.
19. Holmes, Henry Robinson ..	Mining Engineer, Manager, C.P. Prospecting Syndicate, Ld., Kamptee, C.P.
20. Jenkin, William Percy ..	Mining Engineer, Camborne School of Mines 1st Class Diploma, Tirody P.O., Tumsar Road, B.N.R.
21 Jenkins, Joseph Creighton	Mining Engineer, Manager, Manganese Mines, c o. C.P. Prospecting Syndicate, Ld., Tirody P.O., Tumsar Road, B.N.R., C.P.
22. Lang, J. H. ..	Junior Inspector of Mines, India, Dhanbad.
23. Latimer, Joseph ..	Analytical Chemist, Kamptee, via Ramtek, C.P.
24 Lowe, Frank Roper ..	Metallurgical Engineer, Konnagar, Hughly.
25. Mellon, Roland ..	Mine Manager, Gariajore Mines P.O., via Rajgangpur, B.N.R.
26. Parsons, Ernest ..	Geologist, M.Sc., F.G.S. c o

	Names.	Qualifications.
		Messrs. Villiers, Ld., F.1, Clive Buildings, Calcutta.
27.	Penman, David ..	Mining Engineer and Teacher, B.Sc. (Hons. Min. and Geol.) (London), B.Sc. (Hon.) English (Edin). Holder of 1st Class Colliery Managers' Certificate (Home), Principal, Indian School of Mining and Geology, Dhanbad.
28.	Penman, William Brown ..	Mine Manager, Kusunda and Nayadee Collieries, Ld., Kusunda P.O., Manbhum.
29.	Riley, Reginald Conduit ..	Mine Manager, 1st Class Mining Diploma (Camborne School of Mines), Kandri Mine P.O., via Ramtek, C.P.
30.	Ritchie, John Malcolm ..	Mining Engineer, 1st Class Certificate of Competency as Mine Manager (Home). M.I.M.E. Sowardih, Pathardih P.O., Manbhum.
31.	Sommerville, Lawrence Reid ..	Mine Manager, Kusunda and Nayadee Collieries, Ld., Kusunda, E.I.R.
32.	Whitehouse, Edward ..	Mining Engineer, Holder of 1st Class Certificate, Bhaga, Jamadoba, Manbhum.
33.	Whitworth, Charles Stanley	Mining Engineer to the Indian Railway Board, 1, Council House Street, Calcutta.
34.	Wightman, James Heslop	Mine Manager, Holder of 1st Class Mine Managers' Certificate, Bhalgora Colliery, Jharia, Manbhum.

Also, the names of Messrs. D. P. Davies, M. C. Raisurana and E. S. Tarlton were transferred from the list of Associate Members.

Associate Members.

Kothari, Nyalchand ..	Asst. Manager, South Tisra Colliery, Post Box No. 140, Jharia, Manbhum.
Mitter, Bibhuti ..	Inspector of Works (Mines), B.N.R Jamadoba, Manbhum.
Ojha, Narotham Harishankar ..	Proprietor, East Jharia Coal Co., Alliance Colliery, Jharia, Manbhum.
Sarcar, Rabindra Nath ..	Asst Manager. Mining Diploma Holder, B.E. College, Sibpur.
Sen, Prafulla Chandra ..	Asst. Manager, West Jamehari Colliery, Joba, Kalipahari, Burdwan.

Associates.

Hazra, Jnanendra Nath ..	Zemindar and Colliery Proprietor, Samdih P.O., via. Sitarampur, E.I.R.
Standen, Hon'ble Mr. B. P. ..	Indian Civil Service. Nagpur, C.P.

4. The following six members resigned during the year: Messrs. Chas. A. Crofton, S. G. L. Eustace, W. J. Greener, H. A. Pringle, Dr. J. W. Tomb and Messrs. Graham & Co. The Council note with regret the loss by death of Sir Ralph Ashton and Mr. G. F. Adams, ex-Presidents of the Institute, also of Messrs. D. N. Das, A. V. Ethi Raj, Jas. Mackintosh, B. K. Roy and H. L. Wilkinson.

5. The following names have been removed from the list of members under Rule 14 of the Articles of the Association: Messrs. E. L. Barnett, A. G. Bennertz, W. H. Bennett, C. H. Cardozo, H. Chambers, W. Davies, A. A. C. Dickson, J. Kirkwood, Chas. Olden and A. Stead.

6. Meetings of the Institute were held as follows:—

Annual General Meeting ..	Calcutta.	February 11th, 1921.
First Ordinary General Meeting ..	Jharia.	April 25th, 1921.

Second	Ordinary	General	Meeting.	Asansol,	June 20th, 1921.
Third	,,	,,	,,	.. Jharia.	August 1st, 1921.
Fourth	,,	,,	,,	.. Bhowrah,	September 19th, 1921.
Fifth	,,	,,	,,	.. Shampur,	October 10th, 1921.
Sixth	,,	,,	,,	Sodepur,	December 5th, 1921.

At the second Ordinary General Meeting, an interesting and instructive lecture was delivered by Mr. D. Penman, Principal of the Indian School of Mining and Geology, Dhanbad, on mine gases and safety apparatus, which was amplified by the exhibition of safety appliances and illustrated by lantern slides. The first and third ordinary meetings were held for the reading and discussion of papers, whilst the fourth and sixth took the form of visits to the Eastern Coal Co.'s Amlabad and Bhowra Collieries and the Bengal Coal Co., Ld.'s Sodepur 9 and 10 pits, and the Central Power Station and Seetalpore Collieries. The fifth was a geological excursion to the Shampur syncline.

7. The following papers were read or discused :—

(*a*) Note on the Correlation of the Gandudih, Dhariajoba and West Godhur Seams, Jharia Coal-field. By J. Thomas.
(*b*) Preliminary Note on the Ventilation of Indian Mines. By F. L. G. Simpson.
(*c*) Hydraulic Packing in Thick Coal Seams. By H. M. Tarlton.
(*d*) Accidents in Indian Mines, and Mining Legislation. By R. R. Simpson.
(*e*) Additional Notes on the Geology of Guzerat. By E. J. Beer.
(*f*) Ankylostomiasis; its cause, effects, and prevention. By Dr. G. W. Thompson.

The following papers have also been accepted for publication :—

(*a*) The Recent Developments in Lubrication, with special reference to Graphite. By J. Thomas.
(*b*) Notes on a visit to Burma Ruby Mines. By R. R. Simpson.
(*c*) The Training of Mine Managers in India. By D. Penman.

8. Three parts of the Transactions have been published, forming parts 2 and 3 of Volume XV and part 1 of Volume XVI. Vol. XV, part 2 was issued to members on May 21; Vol. XV, part 3, on July 26; and Vol. XVI, part 1, on August 1st, 1921.

Part 2 of Vol. XVI is now in the Press and will shortly be issued, while part 3 is in course of preparation.

9. Eight Council meetings were held during the year for the election of members and the transaction of the current business of the Institute.

It was felt that a rule should be framed dealing with the composition of subscriptions in the case of members retiring from India in order that such members might be able to keep in touch with the Institute. A rule was drafted to take effect, if passed, from January 1st, 1922.

10. *Local Centres.*—A local branch of the Institute has recently been inaugurated in the Central Provinces with its headquarters at Kamptee. Mr. H. D. Coggan has kindly consented to act as the provisional Honorary Secretary.

11. *Subsidence Committee.*—Early in the year the Subsidence Committee discontinued observations and brought their labours to a close. In certain cases of interest, however, the mine owners concerned have kindly consented to continue observations and report on them to the Honorary Secretary of the Institute.

The second and final report of the Committee was submitted to the Council during the year and approved for publication in the Transactions. The report and certain selected plans are now in the Press. Since the lamented death of Mr. G. F. Adams the duties of Secretary to the Committee have been carried on by Mr. R. R. Simpson. The members of the Committee desire to express their cordial appreciation of the valuable assistance rendered by Mr. J. G. Harding of the Department of Mines both in supervising the work of the Surveyor and drawing up the Report. They are grateful also for help given by Mr. J. H. Lang of the same Department.

12. The prize offered by the Government of India for the best paper accepted for publication in the Transactions of the Institute was equally divided between Messrs. E. H. Roberton and H. M. Tarlton for their respective papers on "A Proposed Method of Working a Highly Inclined Thick Seam of Coal" and "Hydraulic Packing in Thick Coal Seams."

13. *Institute Medals.*—The three medals offered for the best papers read before the Institute were awarded as follows:—

(*a*) The gold medal to Mr. E. H. Roberton, and
(*b*) The silver medal to Mr. H. M. Tarlton for their papers mentioned above.
(*c*) The bronze medal to Mr. R. R. Simpson for his paper on "Accidents in Indian Mines, and Mining Legislation."

14. The thanks of the members are due to Mr. B. Heaton (Vice-President) and Mr. J. Thomas for carrying on the work of the Institute from February to October whilst the Honorary Secretary was absent on furlough.

15. The following is the financial statement for the year 1921. The revenue of the Institute for the year was Rs. 14,802-3-8. Of this amount, Rs. 7,536-10-8 was derived from subscriptions, as compared with Rs. 6,706-10-8 in the previous year. The sale of Transactions and maps and advertisements realised Rs. 4,594-6-0, as compared with Rs. 2,808-14-6; and the amount realised for interest was Rs. 2,671-3-0, as compared with Rs. 2,531-4-3. The

MINING AND GEOLOGICAL INSTITUTE OF INDIA.

Balance Sheet as at 31st December, 1921.

LIABILITIES.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
Capital Account—									
Balance of last year's account ..				12,995	0	0	..	..	..
Add—Entrance Fees of—									
30 Ordinary Members @ Rs. 30 ..	900	0	0						
2 Ordinary Members @ Rs. 20 ..	40	0	0						
5 Ordinary Members @ Rs. 15 ..	75	0	0						
2 Associates @ Rs. 30 ..	60	0	0						
				1,075	0	0			
							14,070	0	0
Reserve Account—									
34 Life Members paid in advance ..				..	..	..	1,498	5	4
Sundry Liabilities				..	..	..	529	6	0
Subscriptions paid in advance ..				..	..	..	192	15	0
Provident Fund				..	..	..	1,045	7	5
Library Deposit Fees from Members				..	..	..	10	0	0
Indian Mining and Geological Club ..				..	..	..	3	12	0
Revenue Account—									
Balance as at 1st January, 1921 ..				38,005	6	11			
Subscriptions for 1920 recovered ..				15	0	0			
Add—Surplus for the year ..				4,571	14	1			
							42,592	5	0
TOTAL RS. ..							59,942	2	9

ASSETS.	Rs.	A.	P.	Rs.	A.	P.	Rs.	A.	P.
Value of Publications in Stock—									
As per last account	202	12	3						
Added during the year	34	5	3						
				237	1	6			
Less—Depreciation written off				59	4	4			
							177	13	2
Outstanding Subscriptions				..	..	..	1,178	11	3
,, Bills				..	..	..	399	0	0
Dinner Outstanding				..	..	..	222	0	0
Furniture Account—									
As per last account	705	1	4						
Added during the year ..	305	0	0						
				1,010	1	4			
Less—Depreciation written off				202	0	3			
							808	1	1
Investment Account—									
Government of India Loan, 1930..	33,500	0	0						
Interest accrued thereon ..	754	0	0						
				34,254	0	0			
Government of India Rs. 10,000 Loan 1926 at cost ..	10,125	0	0						
Interest accrued thereon ..	225	0	0						
				10,350	0	0			
Government of India Rs. 8,000, 5% New Loan of 1945-55 at cost ..	7,600	0	0						
Interest accrued thereon ..	83	5	4						
				7,683	5	4			
							52,287	5	4
Cash—									
With the National Bank of India, Ld., on current Account				4,227	9	1			
,, Honorary Secretary, Subsidence Committee				5	2	1			
,, Local Honorary Secretary, C. P. and Berar Branch				100	0	0			
,, Honorary Secretary				536	8	9			
							4,869	3	11
TOTAL RS. ..							59,942	2	9

We hereby certify that we have examined the Books and Accounts of the Mining and Geological Institute of India, with the vouchers for the year ended 31st December, 1921, and have found them correct. In our opinion the above Balance Sheet is drawn up in conformity with the law, and exhibits a true and correct view of the position of the Institute to the best of our information and the explanations given to us and as shown by the books.

Calcutta, 23*rd January*, 1922.

(*Sd.*) LOVELOCK & LEWES, *Chartered Accountants, Auditors.*

MINING AND GEOLOGICAL INSTITUTE OF INDIA.

Income and Expenditure Account for the year ended 31st December, 1921.

EXPENDITURE.	Rs.	A.	P.	Rs.	A.	P.	INCOME.	Rs.	A.	P.	Rs.	A.	P.
To Advertising, Printing and Stationery	..	..	..	679	12	9	By Subscriptions—						
,, Printing of Transactions ..	..	..	..	2,719	13	6	202 Ordinary Members @ 30/- each	6,060	0	0			
,, Charges, general	..	..	..	283	13	0	2 ,, ,, @ 15/- ,,	30	0	0			
,, Establishment	..	..	..	2,245	0	0	50 Associate Members @ 10/- ,,	500	0	0			
,, Expenses of Meetings	..	..	..	266	6	0	10 Associates @ 30/- ,	300	0	0			
,, Postage and Telegrams ..	..	..	..	432	13	0	26 Subscribers	646	10	8			
,, Audit Fee	..	..	..	109	0	0					7,536	10	8
,, Subsidence Committee	..	..	..	918	2	6	,, Interest	..	..	..	2,671	3	0
,, Jharia Coal-field Geological Map Account	..	..	..	100	0	0	,, Advertisement and Sale of Books..	..	..	..	398	6	0
							,, Sale of Raniganj Coal-field Maps ..	..	..	..	1,384	0	0
,, Dinner Account ..	..	..	..	745	4	3	,, ,, ,, Jharia ,, ,, ..	..	..	..	2,812	0	0
,, Institute Medal Account ..	..	..	..	1,120	0	0							
,, Subscription written off ..	..	..	..	300	0	0							
,, Depreciation written off Books ..	..	..	..	59	4	4							
,, ,, ,, Furniture..	..	..	..	202	0	3							
,, Insurance	..	..	..	55	0	0							
,, Law Charges	..	..	..	3	0	0							
,, Balance transferred to Balance Sheet	..	..	..	4,571	14	1							
TOTAL Rs. ..	..	..	..	14,802	3	8	TOTAL Rs. ..	..	..	..	14,802	3	8

Examined and found correct.

Calcutta, 23rd January, 1922.

(*Sd.*) LOVELOCK & LEWES, *Chartered Accountants, Auditors* subscriptions of 273 members were fully paid up as against 250 at the corresponding date last year. The subscriptions outstanding amount to Rs. 1,178-11-3.

The expenditure was Rs. 10,230-5-7, as against Rs. 11,556-7-3 in the previous year. There was a decrease in the expenditure on the Subsidence Committee a/c and the Jharia Coal-field Map a/c, as both the Committees have finished their work. There was, however, an increase in the expenditure on the printing of Transactions, attributable to the greater number of parts printed during the year. The amount of Rs. 1,120 charged against the Institute Medal a/c is large owing to several years' medals being struck at once, as the dies were not available till December 1920. A sum of Rs. 300 has been written off on account of subscriptions not recoverable, as against Rs. 270 in the previous year.

The Subsidence Committee Account is shown separately as under :—

SUBSIDENCE COMMITTEE.

RECEIPTS.	Rs.	A.	P.	EXPENDITURE.	Rs.	A.	P.
To Balance from last year	414	2	4	By Amount disbursed in 1921	918	2	6
,, Contribution by the Institute during 1921 . .	504	. .	2				
TOTAL . .	918	2	6	TOTAL . .	918	2	6

The President : You have just heard the report of the Council read. There is very little to be said on it except that I think it shows a very prosperous year's working. The Institute financially is in a very sound position. I will now call upon the meeting to pass the report and accounts as put forward by the Council.

This was proposed by the President, seconded by Mr. G. H. Tipper, and unanimously carried.

Mr. Oliver then read the names of the officers elected for the ensuing year and the awards of the Prize Committee as follows :—

The voting for the election of officers and Council for 1922 resulted : President, Dr. L. L. Fermor ; Vice-Presidents, Messrs. H. D. Coggan, and H. M. Tarlton ; Honorary Treasurer and Editor of *Transactions*, Dr. E. H. Pascoe ; Honorary Secretary, Mr. E. H. Roberton ; Council, Messrs. J. Brown, J. Coggin Brown, G. Castles, T. Dewhurst, Glen George, H. M. Hance, Alec. B. Hughes, E. D. McDermott, T. C. Murray, J. A. Oliver, N. N. Sarcar, W. Simmons, W. F. Smeeth, E. S. Tarlton and J. B. Wardlaw.

The Institute medals for the best papers accepted in 1921 were awarded as follows : Gold medal to Mr. R. R. Simpson for his paper on Ruby mining in Burma ; silver medal to Dr. G. W. Thompson for his paper on Ankylostomiasis ; bronze medal to Mr. J. Thomas for his paper on Lubrication. Mr. Simpson's paper also secured the Government prize of Rs. 500.

The President : It is my pleasing duty to declare the election of the President, Vice-President and Council for the coming year. I will now ask Dr. Fermor to occupy the chair.

Dr. Fermor then took the chair, amid applause and delivered the following presidential address :—

Presidential Address.

BY

Dr. L. L. Fermor, O.B.E., A.R.S.M., D.Sc. (Lond.), F.G.S.

Gentlemen,—My foremost feeling on rising to address you this morning is one of pride in the honour you have done me in electing me to serve as your President during the forthcoming year. I should also like to have said of pleasure, but my anxiety to serve you to the best of my ability causes this feeling to recede for the present into the background. Perhaps it will appear when my task is done.

From the report of the Council for the past year, which you have just heard, you will observe that the Institute continues not merely to maintain its position, but is able to show an appreciable increase in membership. This increase is in part due to an influx of members from the Central Provinces, attracted by the idea of the establishment of a branch or sub-centre of the Institute at Kamptee. Our Institute, as originally founded, was intended to have a wide scope including the whole Indian Empire in its vision. From the first we have, indeed, succeeded in maintaining a widely distributed membership; but due largely to the concentration of mining engineers in the coal-fields of Bengal and Bihar and Orissa, and the location of the headquarters of the Geological Survey of India in Calcutta, the centre of gravity of the Institute has maintained a somewhat eccentric position on this side of India. It has always been easier to arrange meetings at Jharia, Dhanbad, Asansol, or in Calcutta, than elsewhere, and, in fact, except for occasional excursions, the Institute has never met further afield from Calcutta than Dhanbad. One result of this tendency towards the localisation of the activities of our Institute is that many of the outlying members have rarely or never been able to attend a meeting, in consequence of which, they benefit only by the receipt of our *Transactions*—which, on the whole reflect predominantly the activities of the coal industry—and by the altruistic feeling that, although the tangible return for their annual subscription seems small, yet they are doing their duty in supporting the one institution that represents their profession in India. Such altruistic feelings do not, however, always prevail, with the result that there has been a steady decrease in our outlying membership, with a resultant increasing proportionate membership from this part of India.

This danger of localisation of our interests was recognised by the Council of the Institute some years ago, and a scheme was devised for the establishment of sub-centres in suitable localities. Two such sub-centres were actually established, viz. at Jharia and Asansol; but, as might have been anticipated, they soon died of inanition, for the simple reason that they were unnecessary as being too near headquarters. Sub-centres or local branches are, however, very desirable in certain more distant areas, determined by the distribution of mining, metallurgical and geological interests in India; for we must not forget that, although not specifically mentioned in the title, our interests embrace also metallurgy. We require in particular a sub-centre at Kamptee in the Central Provinces, for which the manganese and coal industries of that province should be able to provide sufficient support ; a sub-centre at Kolar or Bangalore in Mysore, for which the gold, manganese and other mineral industries of Mysore could easily provide a sufficiency of members ; and a sub-centre at Rangoon to serve the manifold mineral interests of Burma, amongst which the most important are lead, silver, oil, tin and wolfram.

Last April I had occasion to make a tour of the manganese districts of the Central Provinces ; I took this opportunity to discuss with the representatives of the local mining industry the desirability of founding such a local sub-centre. Due largely to the energy of Mr. H. D. Coggan, one of your new Vice-Presidents, this sub-centre has now been constituted, and is holding its first meeting on the 31st. The proposal to establish this sub-centre led, it may interest you to hear, to an addition to our membership during the past year of 13 Ordinary Members and one Associate from the Central Provinces, mainly from the manganese industry ; we hope, in addition, to recruit during the present year several more members from the coal-fields of the Pench Valley and Chanda.

You will notice that the new Council includes representatives of Burma and Mysore. I am hoping to induce these gentlemen to undertake the formation of the other two sub-centres referred to above, the institution of both of which seems to be justified by the mineral activities of those regions.

At present mining engineers and geologists qualified for membership of our Institute sometimes express reluctance to join us, for the reason that, as judged by our *Transactions,* our interests are largely with the coal industry. To my many manganese friends in the Central Provinces I was able to meet this objection with the retort that this observation suggested a superior professional *esprit de corps* among the coal-mining community, and they could themselves redress the balance in part by participating in our activities and contributing papers descriptive of their own industry. My retort was taken in the friendly way in which it was given, with the result already referred to. I am hoping that similar arguments may have the same stimulative effect in Burma and Mysore.

In addition to the concentration of mining men and geologists in Bengal, Bihar and Orissa, the Central Provinces, Mysore and Burma, there are a large number of sparsely-scattered mining engineers and geologists working in regions where they are too widely separated, one from another, to render possible the establishment of subcentres for their benefit. We have as members several such gentlemen ; to the remainder I venture to suggest the desirability that all members of the mining, metallurgical and geological professions in India should, in a spirit of professional *noblesse oblige,* seek membership of the only society in India that attempts to represent completely the mineral professions of the country. We should aim at making ourselves so comprehensive and representative in our membership that both the Government of India and the Provincial Governments will realise that, when they are in search of professional opinion on mining and geological matters, as distinct from official opinions for which they rightly turn to the Chief Inspector of Mines and the Director of the Geological Survey of India respectively, they can with confidence look to our Institute for guidance.

A source of loss—not so much financial as professional and personal— to our Institute in the past has been the resignation of members on leaving India. In order to enable us to keep in touch with such members in the future, you have been asked this morning at the extraordinary meeting already held to sanction the introduction of a new rule enabling members, on retiring from India, to compound for future subscriptions on payment of a nominal sum, which has been chosen as roughly that required to pay for the copies of our *Transactions*, which such members will be entitled to receive. As you will have noticed, we are also offering to past members who have already left the country the privilege of rejoining and compounding on the same basis, provided they exercise this option during the current calendar year.

Every President, I have no doubt, likes to feel that his period of office has been marked by some definite action he has taken for the good of his Institute. I shall be very happy myself if my period can be marked by a broadening of our activities due to the formation of local centres and a consequent increase of professional unity throughout the country ; I shall also hope that the new rule referred to above will lead to a considerable increase in the number of our members resident in England, and that it will then be found possible to resume the pleasant annual dinner that one of our founders, the late Mr. Pickering, used to organise in London every summer for retired members and men on leave, thereby keeping our Institute in touch with those who have left the country.

Since our last annual meeting, a new engineering Society has been established in India. I refer to the Institution of Engineers (India), and on your behalf I take this opportunity of holding out to our baby sister the hand of friendship, and of wishing her all prosperity and success. The field of membership open to the new institution is so much more comprehensive than ours that we must not be surprised if our sister, though younger in age, quickly overtops us in stature.

To another infant relation, but two years older than the baby, I must also refer, viz. the Hydro-Electric Survey of India. This is a Department which, if adequately financed, will be able to conduct invaluable researches into the water-power possibilities of the country. The expenditure on such investigations has, however, been made a provincial matter, and as the financial return will not be immediate, such surveys may suffer in competition with apparently more remunerative or urgent provincial needs. I take this opportunity, therefore, of recording my opinion that the investigation of its resources of water-power is really a matter of the first importance to every province where the preliminary investigations already completed indicate possibilities of success. For upon the conversion of such water-power into electric energy may depend the development of electro-chemical industries and the provision of a cheap electric supply for railway transport and for industrial and municipal power purposes.

As most of you know, the Government of India is taking steps to establish at Dhanbad a new Imperial school for high-grade instruction in the principles and practice of mining engineering and geology. The school will probably be called the Indian School of Mining and Geology, and the standard of training will, we hope, approximate to that offered at the Royal School of Mines, London ; but the scope will be less wide, as it is not at present proposed to provide for instruction in metallurgy, which is to be left to the new Metallurgical Institute at Jamshedpur. Speaking in my private capacity, I hope that it may one day prove possible to devise some scheme of affiliation and combine the two institutions into an Indian School of Mines. The need for advanced training in mining and geology, such as we hope to provide in the school, is urgent, but although a site has been acquired, a gentleman imported from home to fill the post of Principal, and a Governing Body appointed to supervise the activities of the school, yet the financial situation is at present so straight that it seems possible that the Government of India may be unable to provide funds in the forthcoming financial year to permit of the commencement of building operations according to the scheme worked out by Mr. Penman, the Principal, and the Governing Body. Should such, unfortunately, prove to be the case, we must then hope patiently for a more favourable wind in the succeeding financial year.

You will notice from the Annual Report of the Council that we have during the past year lost seven members by death. Two of these gentlemen, Sir Percy Ashton and Mr. G. F. Adams, filled the office of President with great advantage to the Institute; but it is unnecessary for me to refer further to their merits, as votes of condolence upon their unexpected deaths were passed at the last annual meeting. As, however, I was not present myself at that meeting, I may be permitted to remark that these deaths deprived the Institute of two staunch supporters and friends.

It would not be fitting for me to discuss the unfortunate circumstances that have led to the departure from India of Sir Thomas Holland, the co-founder with the late Mr. Pickering of our Institute. I feel, however, that I cannot let this event pass without expressing the profound regret that, I know, you must all feel that any circumstances whatever should have deprived India prematurely of the services of such an able man, a man who has done lasting service to the interests of mining, metallurgy and geology in India during a period of three decades. Let us hope that he will find in the old country a fruitful outlet for his abounding energy.

Also, without disrespect to his able successor, we must regret that another of our past Presidents, Sir Henry Hayden, should have felt impelled to resign the cares of office prematurely. Official geology is the loser thereby ; but let us hope that the return to active field work, for which his heart has long yearned, will lead Sir Henry Hayden to discoveries in the Himalayas, Tibet and elsewhere that will contribute appreciably to the solution of that stupendously difficult problem the origin of mountains.

Judging from our activities in the past, one of the chief duties of the President appears to be that of delivering a Presidential Address, and the search for a suitable subject must, I feel, often give the President-elect much food for thought. There are years when one is simply bubbling over with enthusiasm and ideas and when one would welcome an opportunity, such as is now afforded to me to-day, of giving public expression to one's brain-waves. Alas ! There are other years when the mind and spirit are sluggish, and the opportunity does not appear to synchronise with a crest on the curve of one's mental life. I must here confess that I have approached my task with the feeling that the latter alternative describes my own case. And with this feeling upon me I cannot help suggesting that learned societies might be better served if members were asked to volunteer for the office of President, with the object of securing the desirable synchronism to which I have just referred.

The meeting we are holding to-day is the sixteenth annual meeting of the Mining and Geological Institute of India, but as the first Presidential Address was delivered on the occasion of the inaugural meeting at Asansol on the 16th of January, 1906, this present Address is the seventeenth in order. As you all know, this chair has been twice previously occupied by geologists—by Sir Thomas Holland in 1906 and 1907 and by Sir Henry Hayden in 1915 and 1916. As the third geologist to fill this office, I feel that I should first mention the subjects discussed by my geological predecessors in their Presidential Addresses. In Sir Thomas Holland's Address of 1906 the most important feature was the presentation to geological science of a revised classification of Indian geological formations based upon the recognised peculiarities of Indian stratigraphy. The scheme then propounded was so manifestly suitable that it has had an important influence upon many succeeding writings on Indian stratigraphical questions.

In his second Address (in 1907) Sir Thomas discussed the relationship of pure to applied science and the functions of a State Geological Survey, and then reviewed the progress made in the development of Indian metalliferous minerals—copper, aluminium, manganese, and the subjects of electric smelting, nitrogen products, and inorganic chemicals.

In 1915, Sir Henry Hayden returned to the subjects discussed by Sir Thomas Holland in his Address of 1907, and showed the extent to which and the directions in which the promise of the earlier years had been fulfilled. In his second Address in 1916, Sir Henry returned to the same subject and in particular referred to the effects of the war then in progress upon the development of Indian mineral industries.

Now that the great war is finished and nations are attempting to pick up the threads of the avocations of peace, you might, in view of the great interest I have always taken in such matters, anticipate that I should once more review this subject of the mineral development of India and its future possibilities. I am sorry to disappoint you in this. Such a review would at the present moment be a work of supererogation, for the Quinquennial Review of the Mineral Production of India for the five years 1914-1918, published last year in the Records of the Geological Survey of India, places before the public the data relative to the period of the war, and offers such deductions as are possible. In addition, one particular phase of this subject, and one destined to be of great importance to India, has been discussed by me in a paper on the establishment of electro chemical industries in India read at the inaugural meeting of the Institution of Engineers (India) last year.[1]

In default of this subject, you might perhaps look for a dissertation upon the geological aspects of ore-deposits or upon some aspect of the Archaean geology of India, both of which subjects are special loves of mine. Once again, unfortunately, I have taken the bread out of my own mouth, for in my Presidential Address to the Geological Section of the Indian Science Congress in 1919 I took as my subject 'Some Problems of Ore Genesis in the Archean of India.'[2]

Another subject in which I take a deep interest is coal—a mineral which, with its vast range of uses as a source of electricity, steam, heat, dyes, medicines and other chemicals, fills a position in modern civilisation comparable to that occupied by the bamboo and cocoanut amongst less advanced races. But, no. This shall not be my subject. Our knowledge of the coal-fields of India is still in its infancy. My dream is to see the policy initiated of a detailed large-scale geological survey of the Indian coal-fields on new maps. Such work would be not only of supreme importance to Indian coal-mining, but would also, I feel confident, lead the fortunate geologists who carried out such a survey to many happy discoveries. The recents find of marine fossils (*Productus*) by Mr. K. P. Sinor, in beds below the Barakars, in a railway cutting near Umaria in Central India, gives a glimpse of the interest that lies before the geologist who studies Indian coal-fields. I myself saw sufficient in the Bokaro coal-field almost to be converted from my first love, the Archaean rocks, to a new one. This subject is, however, still for the future.

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[1] Electrochemical Industries. Some considerations affecting their establishment in India. *Journ. Institution of Engineers* (India), I, pp. 122–137 (1921).

[2] *Proc. Asiatic Soc. Bengal*, XV, pp. clxx–cxcv (1919).

At this point you may suspect that I am slaying piecemeal all possibilities and am engaged in producing a Presidential Address upon how to write one. I must confess that in a year in which the synchronism between opportunity and ideas appears to be imperfect such a project makes an appeal. Unfortunately, however, there is still one subject left which, I think, can usefully be discussed.

The Utility of Geology to Man.

In his second Presidential Address, Sir Thomas Holland dealt briefly with the functions of a State Geological Survey. I feel inclined myself to enlarge upon this subject by touching briefly upon the varied ways in which the geologist may be of help to mankind. This seems to be the more desirable when I recall the frequency with which geologists are asked exactly how they do their work and the utility thereof.

There was a time in the history of science when the geologist wandering over the country-side, hammer in hand, was, even in highly developed countries like England, regarded as as great a curiosity as the traditional be-spectacled professor armed with a butterfly-net; a time when the act of hammering out a fossil was regarded as a puerile pastime, compared with which the declension of a Latin noun was a manly operation. The pioneer work of William Smith —who was the first to realise (1799) that strata can be recognised by the organic remains they contain, who was the first, therefore, to prepare a true geological map; and who in fact, published the first geological map of England and, Wales (1815)—showed, however, that this apparently childish occupation might lead to results of great importance.

Geological Surveys.

It is many years since the first official Geological Survey Department of any country was established, namely, that of Great Britain in 1835; and nowadays the utility of such a department is recognised in all civilised countries. Such a department was definitely established in India so long ago as 1851, the date of arrival of Dr. Thomas Oldham, the founder of the Geological Survey of India. Indeed, if precedence as a civilised country were to be determined by the order of establishment of official Geological Survey Departments, India would be found to occupy a high place in the list, for the only older Geological Survey Departments still in existence are those of Great Britain, Canada (1842), and Spain (1849), although geological work had been financed officially by certain countries prior to this date, *e.g.* France (1823), Massachusetts (1830), Belgium (1836), and Austria-Hungary (1849).

Governments, even of civilised countries, would not, however, incur the expense of maintenance of such departments were their functions purely ornamental, and the public often enquire therefore the *raison d'être* for such work. The answer is, of course, that to any country not largely built on alluvium systematic geological survey operations are of great economic importance, not only to the mining industry, but also in the solution of many engineering, agricultural, and other problems of benefit to mankind.

Since, however, these benefits often produce but an indirect effect upon the State treasuries, many countries regard themselves as unable to maintain as large a corps of geologists as the welfare of the country demands. It is necessary, therefore, to consider the most advantageous and economical policy to be adopted in utilising the services of such geologists as exist. The invariable tendency of the administration in any country is to employ their official geologists direct upon mineral problems, as therein appears to lie the greatest benefit. Such a policy is, however, as a rule, short-sighted, and it cannot be too strongly emphasised that the first and most important duty of the official geologists is the preparation of geological maps, upon the accuracy of which the solution of most geological problems ultimately depends. In the earlier years of the survey such work must be conducted on broad general lines with the object of indicating the general structure and the outlines of the geological history of the country. On the completion of this general survey, the necessity arises for a more detailed survey on larger scale maps, with the object of publishing sheet by sheet geological maps, if possible on the scale of one-inch to the mile, of those portions of the country that possess features of geological interest.

In practice it is not, as a rule, possible to adhere strictly to the sequence mentioned above; and in India, for instance, although we have not yet completed the first general geological survey of India and Burma, we have already surveyed considered tracts on this scale of one-inch to the mile.

The lay public often express curiosity concerning the exact procedure followed by the geologist, and usually suppose that in the course of his field-work he indulges in frequent digging and boring operations in order to locate his boundaries and ascertain the structure. The geologist welcomes and utilises with gladness the evidence exposed by man in quarries and mines and the records of boring operations for mineral deposits, oil, and water, conducted by mining companies and public bodies. But in the main he bases his deductions upon the evidence afforded by natural rock exposures on hill and plain, and in river and stream bed. He is, in truth, a scientific detective stalking up and down the land, building up his case from a multitude of apparently insignificant clues, and producing as his record maps that to the initiate explain the structure of the land and its physical history.

Structural problems.

Let us now review briefly the utility of these maps to mankind. In the first place, geological maps record the distribution of the successive geological formations and show in particular the relationship of one layer or stratum of rock to another, and the direction in which and the angle at which these strata dip, thereby making evident to him who can read the geological structure of the country. Armed with this knowledge, the geologist is in a position to advise upon a variety of problems dependent on structural considerations. He is able, for example, to advise on the liability of hill-slopes to land-slips, and thus to help municipalities in the selection of building sites, and railway companies in

Stability of hill-slopes.

the alignment of their lines; if sites already utilised for building or existing railway lines have been found in practice to suffer from the devastating effects of land-slips, as in Darjeeling and on the Assam-Bengal Railway respectively, the geologist is ready to investigate the extent to which such land-slips can be mitigated or prevented in the future.

Dams and reservoirs.

The geologist may be equally helpful with advice on the suitability of selected sites for dams and reservoirs, where questions, not only of structure, but of the porosity, solubility and state of decomposition of the underlying rocks, require consideration.

Earthquakes.

The study of earthquakes is also within the scope of the geologist. By statistical treatment he is able to determine what types of geological structure can be correlated with greatest frequency of incidence of earthquakes, and consequently to advise, though at present only in a broad way, on the liability of projected and existing engineering works to damage due to seismological causes. He is also able from his knowledge of earthquakes—what they are and their causes—to offer suggestions concerning the construction of buildings in regions specially susceptible to earthquakes, such as Assam.

Discovery of mineral deposits.

During the field-survey work required in the preparation of geological maps, the movements of the geologist are guided primarily by the course followed by geological boundaries; the geologist will trace through jungle or desert, over hill and dale, the boundary between two different rock formations with the same keen intentness and suppressed excitement that characterise a hunter tracking his quarry. At such times mineral deposits are of subordinate importance to the problem in hand, and often escape discovery unless they happen to lie near geological boundaries. Nevertheless, during the progress of such work, many mineral deposits of value have been discovered. Thus officers of the Geological Survey of India have at various times discovered coal-fields in many parts of India, chromite in Baluchistan, bauxite in Bihar and Orissa, Bombay, the Central Provinces, Madras and elsewhere, iron-ores in several provinces, manganese-ores in the Central Provinces and Madras, wolfram in Tenasserim, and many other less important minerals; they have also noted in the course of their work the distribution of the commoner rocks of economic value, such as limestones, clays, cement-making materials and building-stones.

Special mineral surveys.

In addition to the fundamental geological sheetmapping already referred to, the geologist is often called upon to undertake mineral surveys specially directed towards the study of the mode of occurrence and origin of important mineral deposits to which public attention has already been attracted. As a result of such work, a monograph may be published explaining in full the geological and economic data applicable to the mineral in question, rendering intelligible to the miner the structure of the deposits with which he is concerned and consequently enabling him to lay out his mine to the best advantage. Thus, the Geological Survey of India has published special monographs on coal, corundum, manganese-ores, mica, and petroleum.

Prospecting.

Armed with his geological maps and with the knowledge derived from such special mineral surveys, the geologist is frequently in a position to offer to the public, as required, invaluable suggestions concerning proposed prospecting operations. If asked by a prospector where he can with the best advantage search for specified minerals, we are usually able to name the geological formations and consequently the districts in which he has the best chance of success. Based on our knowledge of the relationship between mineral deposits and geological structure and age, we are also frequently able to proffer negative advice and prevent the waste of valuable money on a search for a mineral in country where its existence is almost a geological impossibility, *e.g.* for oil in the ancient crystalline rocks or coal in the Deccan Trap basalts.

One of the greatest uses of published geological maps is to the geologist in the private employ of mining and oil companies, particularly the latter. The oil geologist will plan his campaign after a study of the official maps, where such exist. A notable example of success following on such a campaign was the speedy discovery of oil at Khaur near Rawalpindi in the Punjab. An examination of our geological maps indicated the existence of a promising anticline: a more detailed survey on the spot by Mr. E. S. Pinfold, Geologist to the Indo-Burma Petroleum Company, confirmed this indication, and boring operations undertaken by the Attock Oil Company soon led to the discovery of oil-sands within 400 feet of the surface.

Water supplies.

In most countries the provision of adequate supplies of water for municipal purposes and for agriculture is one of great importance; and in India, with its hot climate and its long seasonal periods devoid of rainfall, the question of underground water-supplies is often of vital importance, in consequence of which the geologist receives frequent calls from towns, railways and mills for advice concerning the distribution of underground water and the probability of success in the event of boring operations being undertaken. Provincial Agricultural Departments are now beginning to display great activity in searching by wells and borings for water for irrigation purposes, and to realise the benefit of enlisting the help of the geologist. Artesian water is, of course, the type of supply generally desired, but unfortunately, the basin-shaped or synclinal structure necessary to permit of the accumulation of water under pressure is relatively rare in India, most of the water obtained from underground sources being at the best sub-artesian. On the basis of his knowledge of the geological structure, the geologist is often able to advise against the heavy expenditure necessary for the discovery of deep-seated artesian supplies and thus save the waste of considerable sums of the ratepayers' money.

Building stones and road metal.

From his knowledge of the chemical and mineral composition of rocks, the geologist is able to advise on the suitability of particular stones for building and road-making. To illustrate the former I may mention that it is directly due to the initiative of the Geological Survey of India that the Victoria Memorial Hall in Calcutta was not constructed of Italian or other foreign marbles. By a series of laboratory and weathering tests we showed not merely that the Archaean marbles of India and Burma are as good as the famous marbles of Italy and Greece, but that they are in every respect more suitable, being less porous and soluble, and more resistent to weathering.

Soils.

From his study of the composition of rocks and of their degradation products, the geologist may also be of service to the agriculturist in enabling him to understand the distribution of the different types of soil, the conditions of their formation, and the depths to which they may persist.

Not only is the knowledge of the geologist of value to the miner in his search for minerals, but it is also of great value in enabling the miner after his deposit is found to devise the most suitable scheme of development.

Development of ore-bodies: pitch.

As an example I may refer to the phenomenon of *pitch*, by which I refer to the angle of dip of the axes of anticlines and synclines. The normal text-book type of folding is one with horizontal axes resulting in parallel outcrops. In practice, however, this axis often possesses a decided inclination in one direction. This inclination, which is known as the pitch, is frequently of the greatest importance in connection with the structure of mineral deposits. In the case of oil, the largest accumulations are to be found at the upper end of a pitching anticline, whilst with artesian water the largest supplies will be found in the lower portions of a pitching syncline. In the Central Provinces the manganese-ore bodies and associated manganese-silicate-rocks occur at a definite geological horizon in an intensely folded series of very ancient rocks. A single sheet of ore is often folded several times, and it is an exception for the axis of folding to be horizontal. The pitch is, in fact, often as high as 30 or 40 degrees, and the consequent effect upon the direction in which a manganese-ore body extends underground is often surprising if the cause is not understood. In my tour round the manganese mines last April after an interval of several years, I found the effects of this pitch upon the shape and extension of the ore-bodies well exposed; this enabled me to explain to the mine managers many apparent vagaries in the behaviour of their ore-bodies and to indicate the direction in which the extension of future workings should be planned.

Mineral policy.

From his knowledge of the conditions of occurrence of minerals and of the variations in their composition and distributions and, consequently, of the methods of work suitable to each case, and also from his knowledge of the quantities of mineral available, the geologist is able, with confidence, to advise Government upon the desirability and practicability of regulations to control the mining industry, and, in fact, generally to advise on questions of mineral policy.

Monetary value of geology: royalties.

From the foregoing brief statement of the diverse directions in which the knowledge of the geologist may be impressed to the service of mankind, it is obvious that the operations of a Geological Survey Department must frequently be of financial assistance to Government, though usually in an indirect way. This value is difficult to evaluate in terms of rupees, but an idea of the minimum monetary value of geology to a country could be obtained by calculating the royalty that accrues yearly to Government and realising that a considerable proportion of this income is directly or indirectly the fruit of the labours of the geologist. In India the royalties on minerals in Government lands are paid into the provincial treasuries. No data are available to me showing the income actually thus realised; but a rough calculation based on the quinquennial average figures of 1914–18 and the standard rates of royalty presented by the mining rules shows that for the eight most important minerals excluding salt and saltpetre, which are administered by the Salt Dept., the royalty receipts to Government and to other owners of mineral rights in India must be of the order of a minimum of

Rs. 84 lacs annually[1] or 35 times the annual cost of maintenance of the Geological Survey of India during the same period.

Influence of geological history upon human history.

One might continue to enlarge upon the benefits of geology to mankind; this I do not propose, but I cannot omit a reference to the influence of geological history upon the human history of a country. A glance at the excellent layered map of India, published by the Survey of India on the scale of 32 miles to the inch, suggests at once to anybody familiar with the main outlines of Indian human history the controlling effect that the surface features, and therefore, the geological history, upon which these features depend, must have had upon this human history. Speaking very generally, India is built of three topographical and geological regions: in the centre and south lies the roughly triangular Peninsula with its many jungle clad ranges of moderate height and the geological composition and history pertaining to a relatively stable block dating from very ancient times. Thrust apparently towards this block on the north-west, north and north-east, lie the festoons of young mountain ranges of Baluchistan and the North-West Frontier on the north-west, the Himalayas on the north, and the Burmese ranges on the north-east. Occupying the surface between these mountain ranges of youthful history, and the ancient block of the Peninsula, lies the fertile alluvial tract of the Indus, the Ganges, and the Brahmaputra, upon which, with its, in places, dense population, so many of the recorded events of Indian history have taken place. The fringing mountains have, on the whole, acted as barriers, isolating India from the surrounding countries, but not completely. For cutting these mountains are certain passes which, on the north-west, have permitted the periodical inundations of India by wave after wave of Aryan and Turanian mankind, and on the north-east by waves of Mongolian mankind. The primitive Dravidian and Kolarian races have not, however, suffered extinction, but have retreated to the wilder hills of the Peninsula, where they still persist as the so-called aborigines, primitive man thus associating himself appropriately with primitive geology and the later human arrivals with the fertile and recent alluvium.

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[1] Calculated as follows:—coal, 5% on spot value; gold, 2½% on gross value, petroleum, 8 annas a barrel; manganese-ore, 4 annas a tin: wolfram, 2½% on spot value; mica, 5% on export value; lead-ore and lead, 2½% on spot value; silver, 2½% on gross value.

It would be a pleasing task, which, one may hope, will be undertaken by some one in the future, to write a brief history showing in some detail the ultimate dependence of the historical events of this country upon the physical and geological peculiarities thereof. The dramatist, in introducing his play, describes the arrangement of the stage in static terms, with a table in this position and a window in that. My geologist-historian would describe the setting before the advent of man as something kinetic, with the properties moving into position, each to produce particular effects in events yet to happen. He would mention the as yet unbroken Gondwana continent, with its northern shore line stretching somewhere across the northern edge of the Central Provinces or the southern edge of the United Provinces, and with ocean known as Tethys lying over the plains of the Punjab and Hindustan and a large portion of the present Himalayan region, relieved by certain peninsulas and perhaps island ranges, such as the Aravallis and portions of the older rocks of the Himalaya.

He would sketch lightly the gigantic concatenation of events by which the Deccan Trap lavas were poured out in successive eruptions over vast areas of Gondwanaland, whilst deposition still proceeded in the northern sea of Tethys. He would describe the smash-up and foundering of a large portion of Gondwanaland leading to the formation of the Arabian Sea and the Bay of Bengal, where land previously was, thus providing the seas over which the latest human invasion was one day to take place, and the coasts upon which the landings would be effected; accompanied by the preservation of a remnant of this old Gondwana continent as the triangular peninsula of India with its hill refuges for the preservation of the primitive tribes yet to come. He would describe the gradual rise of the fringing festoons of Baluchistan, the Himalayas and of Burma, providing barriers to protect the future Hindustan, rendered imperfect, however, by the subsequent excavation of passes to admit invaders. He would describe the silting up of the seas now occupied by the Indus and Gangetic alluvium, and the evolution of Bengal and the site that has permitted the foundation and growth of this city of Calcutta. His history would also render clear the precise sequence of geological events that were inevitably to lead to the foundation of a capital city at the apex of the Peninsula where Delhi now stands, and which were bound to result in the country near Panipat becoming famous in Indian history as a decisive battle ground where hordes of invaders from the north-west would at recurring points of time meet the already established races bent on protecting and retaining the fertile plains of the United Provinces and Bengal to the east. The geological portion of this historical sketch would also touch briefly upon the events that led to the accumulation of certain elements into valuable mineral deposits that were destined to be plundered and utilized by man yet to come. It would, for instance, show how the accumulation of the iron-ores of Orissa in the remote Dharwar or Cuddapah times followed by the deposition of vegetable debris (later to become consolidated as coal) in the Damodar valley in later Gondwana but still very early times, would inevitably —after the sea routes for the white invaders had been provided by the foundering of Gondwanaland—result in the primitive village of Sakchi, still to be born in the dim-distant future, being eventually replaced by the industrial city of Jamshedpur utilising the deposits of iron-ore and coal just referred to.

It is, I think, unnecessary for me to enlarge further upon this theme in order to convince you of the profound importance of a correct understanding of the geological history of a country if the human history thereof is to be appreciated in all its bearings.

Conclusion.

Although the foregoing notes are but sketchy, yet I feel that I have said sufficient to demonstrate that geological science is of use to mankind in a great variety of ways. Geological science is itself based upon a number of other science —chemistry, physics, botany and zoology—in consequence of which the student of geology is compelled to spread his interests over a wide range and consequently to take broad views; to the philosophical mind, in fact, geology frequently makes a strong appeal. The geologist must, however, beware that his consciousness of the interest and importance of his science does not lead him to mental arrogance. He may be apt to feel that because he understands—or thinks he does—how the world was made, therefore he has a sort of proprietory right in old mother earth, so that his greatest service to mankind is that of providing the earth for his poor feeble fellow men to dwell upon. Once more, let him beware; he has forgotten the astronomer, who thinks not in terms of one world, but of universes containing an apparent infinity of worlds.

Nevertheless, to the geologist the well-known quotation from Wordsworth gives great comfort:—

"To the solid ground of
Nature trusts the mind which builds for aye."

The presidential address having concluded, Mr. R. R. Simpson rose to propose a vote of thanks to the retiring President, Mr. George Miller, and other officials for their work during the year. He said: The office of President is no light task. Mr. Miller has been diligent and he has the satisfaction of knowing that during his year of office the membership has increased and we have had quite a number of papers read at meetings.

Mr. Purdy: I have much pleasure in seconding.

The proposal was unanimously carried.

Mr. G. H. Tipper proposed and Mr. J. Thomas seconded, the re-election of the auditors, Messrs. Lovelock and Lewes. This was agreed to.

Mr. C. B. Chartres then said: I have been asked to propose a vote of thanks to Dr. Fermor for his very interesting address. I rise to do so with diffidence and pleasure—with diffidence, because I come here as a layman to this Institute and the layman's idea of geology is that it is a subject as dry as dust. (Laughter). But I think Dr. Fermor is to be congratulated on having given us an address on geology which, far from being dry, has been most interesting and has opened up vistas of thought to most of us which will be very profitable. I should like to thank Dr. Fermor on behalf of the Institution of Engineers for his very kind remarks. I have something to do with the Council work of that Institution and with trying to establish Local Institutions in different parts of the country and it is very flattering to that baby Institution to see the Mining and Geological Institute is trying to develop its scope in the same way. I think the vigorous measures which Dr. Fermor is taking will promote the welfare of this Institute and add to the influence of its transactions. I propose a very hearty vote of thanks to Dr. Fermor for his interesting address.

Mr. Crawford: I have pleasure in seconding that.

Mr. R. R. Simpson then read his paper on Ruby Mining in Burma.

Notes on a Visit to the Burma Ruby Mines.

BY

R. R. Simpson.

(With four Plates.)

Situation, etc.

The Burma Ruby mines are situated about 90 miles north of Mandalay. Up till recently there was a Burma Ruby Mines District, but in 1920 they were included in the Katha District, of which the Ruby mines area now forms a subdivision. To reach the mines it is necessary to travel for a day or one and a half days by steamer up the Irrawadi River above Mandalay to Thabatkyin, from whence there is a good motor road to Mogok, which is 60 miles distant to the east and at an elevation of nearly 4,000 feet. There is a good motor service and dak bungalows both at Thabatkyin and Mogok, and also at intervals on the road. The town of Mogok contains some 10,000 inhabitants, all of whom are engaged directly or indirectly in the gem mining, cutting, polishing and selling business. The offices of Messrs. The Burma Ruby Mines, Limited, are situated near the town and most of the Company's officers reside there. There are also the usual Government officials and a detachment of Military Police.

The ruby mining area is a tract of country, some 20 miles from east to west by 10 miles north to south. The whole area is known as Mogok and was formerly, as stated above, the administrative area known as the Ruby Mines District. Outside this area no rubies are known to occur.

The gem-bearing deposits.

The principal gem carrying deposits are situated in the valleys of Mogok, Kathe and Bernardmyo. Kathe is 8 miles west of Mogok, and the road from Thabatkyin passes through it. Bernardmyo is 10 miles north-west of Mogok over a rough bridle road. At one time the Company worked a considerable mine at Bernardmyo. The principal mines are at Mogok and Kathe.

The gems found are numerous, but those of value are ruby, sapphire and spinel. About 90 per cent of the gems are rubies. Other stones are topaz, peridot, zircon, beryl, aquamarine, lapis-lazuli, moonstone, etc. They occur in alluvial sands and clays overlying an eroded limestone floor. The depth of these alluvia is from 20 to 70 feet, and they are richest near the bottom. The hills enclosing the valleys are largely gneisses and highly crystalline limestones, and contacts between the limestone and the gneiss can be seen in the mines and may have some connection with the evolution of the gems. Rubies occur in the limestone near the contact, and sapphires have been seen *in situ* in the gneiss, but mining in the limestone or gneiss is not profitable and has never been practised.

Ruby and sapphire are gem varieties of the mineral corundum, which is pure alumina, an oxide of aluminium and one of the chief constituents of common clay. The abrasive material, emery, is an impure form of corundum. Corundum is harder than any mineral except the diamond.

The Mining areas.

The principal concessions held by the Company are as follows:—

Name of Concession.	*Area of Concession.*	*Area of Quarry.*
Mogok	2½ miles by ½ mile	4,000 ft. × 1,000 ft.
Kathe	2 miles by ½ mile	1,500 ft. × 1,000 ft.
Kabaing Kin Bernardmyo	Worked by native methods formerly. Work is now closed down	

The mines.

The principal mines worked by the company are Taroktan and Redhill mines (2/3 mile apart) at Mogok, and Kathe and Dantagutaung Mines at Kathe. The revenue derived by Government from the Company was £16,000 in 1919. There is also a large number of mines owned and worked by Burmans, Shans and others. Each worker in these mines has to obtain a license and pay a fee of Rs. 20 per month. In 1919 some 800 licenses were granted and the fees realized over four lakhs of rupees—a much larger revenue than that paid by the Company. These fees are collected and the mines are inspected for Government by Inspectors employed by the Company, and the Company is allowed 10 per cent of the fees for the trouble.

Mining method at the Company's mines.

The ground is mined entirely by opencast quarrying (see Plate 3). The quarry faces are kept at a natural slope and worked in conical bays. Shovellers break down the ground, and it slides down to the apex of the inverted cone of a bay where it falls into a rough hopper, and from thence into trucks which run on lines radiating out from a common centre where there is a turn plate. From thence the trucks are hauled by endless ropeways to the washing mills, in some cases as much as half mile distant. After washing the concentrate goes to a sorting shed.

About half of the ground is broken down by 'monitors' which work at pressures of from 100 to 250 lbs. per square inch. (The water is piped from springs high upon the mountain slopes). The mixture of sand, gravel and water is pumped up by sand and gravel pumps or hydraulic elevators to sluicing plants. The rich concentrate obtained from the sluices is taken direct to a sorting shed. At each mine about 600 tons of material per day is mined by hand and 500 tons per day by sluicing. The average mining cost is about eight annas per ton, and the value twelve annas per ton.

The bottom of a quarry presents a remarkable appearance. It is occupied by the irregular surface of the eroded limestone, which forms a multitude of hummocks and pinnacles of rock of fantastic shapes, from 10 to 20 feet in height, pierced in numerous directions by narrow irregular cuttings through which pass the tramways required for transporting material from the faces.

Explosives.

No large quantity of explosive is needed. It is required only for blasting out the cuttings in which the tramways are laid, and for breaking up large boulders. Dynamite with ordinary fuse is used, and the shots are fired during the midday interval by the European miners and overseers.

Drainage.

Water is removed from the mines by means of drainage canals constructed from end to end of the open workings. These canals conduct the water into main drainage tunnels. The Taroktan tunnel, which drains all the mines at Mogok, is a mile in length and about 150 feet below surface level. When a mine is worked down to the drainage level the canals are deepened and the newly drained surface is then worked down. In this way deep canals are avoided and a large shallow surface of earth is made available for work.

Power.

All machinery is driven by electrical power generated by a hydro-electric plant situated in the Yeni Choung (river) about one and a half miles south of the Taroktan (Mogok) mine. A masonry dam, 11 feet high upstream and 32 feet high down stream, directs a portion of the flowing water into a supply channel, which feeds a pipe line (32″ to 28″ diameter), which carries the water to a power house, 2,250 feet down stream. The head of water is 205 feet, and it is used in three sets of tandem Pelton wheels (2′ 6″ diameter, double nozzle) which drive three alternators at 450 revolutions producing 450 Brake H.P. (peak load 600 B.H.P). The current is transmitted at 2,500 volts to the Mogok mines (2½ miles) and the Kathe mines (9 miles).

Haulage.

Near the faces of the quarry the trucks are propelled by hand, but the bulk of the haulage is done by endless rope with plain 'Y' clips. Direct rope haulage is employed to a small extent. The trucks are steel boxes mounted rigidly on channel iron frames.

Machinery.

The ground worked down by shovellers or washed down by 'monitors' is elevated by gravel pumps or hydraulic elevators to the sluices, which are worked by gravity. The mixture is passed over screens, where more water is introduced. The lumps fall through the screens washed clean of mud and are conveyed to the dump after breaking up and rough sorting. They rarely carry gems. The finer material (2″ cubes) passes with a stream of water into a sluice box (see Plate 1) which consists of a sloping trough (about 60 feet long by 10 feet wide) where the gem concentrate is caught in a series of two pairs of three riffles, one pair below the other. The waste material passes over the end of the sluice and the concentrates are drawn off from the riffles every evening through side doors and conveyed to the sorting shed in trucks with locked covers.

As stated above the material got by hand is conveyed to washing mills and is dumped over screens, through trommels and into washing pans (circular pans with revolving arms where the mud and waste rock is washed out). At the end of the day the rich concentrate in the pans is washed out through doors in the bottom of the pans, and conveyed to the sorting sheds in trucks with locked covers.

The concentrates from the sluices and the washing mills having reached the sorting house (see Plates 2 and 3) are introduced into a series of trommels. The material larger than 5/8″ goes direct to a sorting table. The finer material passes into jigs where a gravity separation takes place, the gems being removed periodically through doors in the bottom of the jigs, the light gravel washing out at the top. From the jigs the gem material passes to sorting tables. The first sorting is done by Europeans who pick out the gems of value by hand. The second and third sorting is done by coolies who pick out any gems that have been missed. The sorting shed is a strongly fenced enclosure with locked doors. Whilst at work each coolie is closely watched by a Gurkha guard. They are stripped and searched at the end of the shift.

The tailings or fine gravel and mud passing from the sorting shed is treated in hand pans by outsiders not employed by the Company. These are women only and they, by virtue of a hereditary right known as 'kanesi'[1] are allowed to do so without license or fee. They earn from 2 to 4 annas per day by picking out very small gems which they sell locally.

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[1] By the hereditary right of 'kanesi' women are allowed to wash, without fee or license, the beds of any streams but not the banks, and the rejections or refuse of any mine. Hence it is only in the tailings from the washing mills that women enjoy the right so far as the Company is concerned.

Women contractors (not working under the right of 'kanesi') purchase the sand and sorted gravel for an average sum of Rs. 200 per month per mine. They sub-let it to other women who treat it in hand pans and re-sort it, obtaining small gems which are sold as jewels for watches.

The native mines and miners

The native mines are worked over a large part of the ruby mining area and are widely scattered. There is a large group being worked in the Kathe Valley to the north of and close to the Company's mines. The miners are nearly all Burmans or Shans.

No machinery is allowed. Dynamite may be obtained from the Company, but all shots are fired under the supervision of the Company's European Inspectors.

The native mines are of various kinds, chiefly :—

(1) Square pits from 3 ft. to 20 ft. square.
(2) Hill side cuttings.
(3) Tunnels following rock fissures.

The depth of the pits is from 20 to 30 feet. Water is dealt with by means of bamboo pumps. Many of the shafts are timbered in a most ingenious fashion. Some of the larger shafts have as many as 12 compartments. The spoil is removed in small baskets by means of balanced bamboo levers such as are used in wells all over the East.

The native miner is quite a good civil engineer in a rough way, bringing water for considerable distances, sometimes many miles, by means of ditches. The alignments of these ditches are made without any survey or means of obtaining levels, and it is extraordinary how accurate they are.

Supervision of Company's mines.

A large European and Eurasian staff is employed—not less than thirty persons.

At each mine there is a European miner and assistant miner on duty during the whole of each shift.

Labour.

The Company's miners are chiefly Chinese Shans, but there are also Burmans and Indians. The numbers are from 200 to 300 at each mine, but one-third of these are employed in the dressing plant They are paid at the rate of one rupee per day. The shift is ten hours, but they have half an hour off for rest. At Kathe mine there are both day and night shifts. The mines are lighted by electricity at night.

The Company house all their employees except the coolies and Indian durwans. They also provide water, electric light and medical attendance to their European and Eurasian staff, and water to the coolies and durwans wherever possible. The coolies at Mogok live in the town which is sanitated by a Local Fund Committee. The latter also provides water. Cases of sickness are treated in the Government Hospital and Dispensary which is in charge of a European Civil Surgeon. The Company subsidise the Civil Surgeon and his staff, and place funds at his disposal for the purchase of medicines and necessities.

Climate, etc.

The climate is salubrious. There is little malaria and cholera is rare. Epidemics of small-pox and plague have occurred. The rainfall is about 100 inches, and the temperature rarely reaches 90° F. In the winter months thin ice is often seen on the surface of pools. The surrounding country is well wooded and there is abundance of timber for mine purposes and for use as firewood.

By the kind permission of Mr. F. Atlay, General Manager for the Burma Ruby Mines, Limited, extracts from a hand-book published by the Company are attached. The writer has pleasure in expressing his thanks to Mr.

Atlay for the facilities afforded in obtaining material for this note, and to Mr. J. F. Halford-Watkins, the Company's Chief Engineer, who has kindly revised the proof and supplied the illustrations.

APPENDIX.

Being mainly extracts from a handbook entitled "Rubies" written by Noel Heaton, B.Sc., F.C.S., and published by the Burma Ruby Mines, Limited.

ARTIFICIAL RUBY AND ITS DETECTION.

All natural stones possess to a greater or less extent characteristic internal structures, blemishes and flaws—very minute in choice specimens, but as a rule very plentiful.

All artificial stones possess imperfections consequent upon the method of manufacture, but these are much less noticeable as a general rule and are quite different in character.

These differences in structure form the basis of an infallible and readily applied test for the detection of artificial ruby (see Plate 4).

SPURIOUS NATURAL STONES.

There are several species of precious stone, less valuable than the ruby, which approximate to it somewhat closely as far as colour is concerned, notably :—

The red spinel, or Balas ruby.
The pyrope garnet, or Cape ruby.
The red tourmaline.

All precious stones possess certain definite physical properties, however, which are capable of accurate measurement, and instruments have been devised for this purpose suitable for the use of the expert. A very little practice in the use of these instruments renders the identification of any of these substitutes for real ruby a matter of ease. The tests can be performed very rapidly, and the result is to replace opinion by scientific certainty, as no two specimens of precious stone have exactly the same properties, and the properties of the ruby are quite exceptional. The most useful tests are described below.

THE DICHROSCOPE.

This little instrument is simple to use—all that has to be done is to fix the stone to the holder and hold the instrument in such a position that it is well illuminated, when two images of the stone will be seen, side by side. If the stone is a real ruby these images will change colour, from pink to deep red, if the holder is rotated so as to bring the stone into different positions. Red tourmaline also shows this variation of colour, and in some cases to an even greater extent than ruby, but in the case of the spinel and garnet mentioned, the colour always remains the same, no matter how much the stone is rotated.

SPECIFIC GRAVITY TEST.

Ruby is a very heavy stone—more than four times as heavy as water, whereas the majority of other stones are somewhat lighter than this.

The relative weight of stones of the same size would be as follows:—

Ruby	4·03
Spinel	3·60
Garnet	3·78
Tourmaline	3·10

To identify substitutes for ruby by means of this property, one takes advantage of the fact that a solid will sink in a liquid lighter than itself, but float on the surface of one that is heavier. By dissolving a substance known as thallium silver nitrate in the right quantity of water, we can prepare a liquid which is exactly four times as heavy as water. If some of this is kept in a little tube, a real ruby will just sink in it, whereas the substitutes will float on the surface.

The specific gravity can be determined more accurately by means of a balance. Care and an elementary knowledge of arithmetic are all that is necessary.

THE MICROSCOPE.

The only instrument of any real value when trying to distinguish between a real and a reconstructed ruby is the microscope. It is purely a question of the internal construction of the stone, i.e. bubbles, striations, inclusions and silk. A one-inch objective is good enough, but a half-inch is better. With this the shape and arrangement of the bubbles can be seen with ease, and bubbles are the concrete test (see Plate 4).

EXPLANATION OF PLATES.

Plate 1. Diagrammatic sketch of sluicing plant.
,, 2. General arrangement of a sorting shed.
,, 3. Fig. A, A glimpse of the Burma Mines; Fig. B, Sorters at work.
,, 4. Differences between real and artificial stones.

DISCUSSION.

The President.—Mr. Simpson has read to the Institute a paper of a very interesting type and I think it is a type of paper that we should attempt to get as often as possible. An interesting point is the fact that the reconstructed stones, though artificial, are real stones.

Mr. Ghose.—Mr. Simpson's paper is very interesting. It is the second paper only on the Burma Ruby Mines that I have come across. I should like to ask the writer what was the special difficulty in recovering rubies from limestone.

Mr. Hughes.—Would Mr. Simpson tell us how rubies are re-constructed ?

Mr. Simpson.—I think I should have to write a separate note on that. I don't even know the name of the process. I think we must ask the President, who knows more about it.

The President.—I am afraid I don't know the details, but they start with a piece of real ruby, and then add to it powdered ruby melted by being passed through intense heat; and the stone is gradually built up step by step. Perhaps Mr. Ghose would enlighten us.

Mr. Ghose.—A small fragment of ruby is taken, heated to white heat, and very finely powdered ruby dust is injected on the ruby.

Mr. Thomas.—Would Mr. Simpson give us some idea of the method of distinguishing between various kinds of rubies. A little while ago I spoke to a jeweller in Calcutta, who had been in the country for many years and was informed that shortly after one of the Burma wars a number of British soldiers passed through Calcutta. They had purchased rubies in Burma and called on the jeweller and asked for a valuation. The jeweller, instead of finding the rubies worth thousands of rupees, discovered that the soldiers had bought glass from Birmingham.

Mr. Brown.—Some information regarding the gravel pumps used on the mines would be of very great interest to members.

Mr. Simpson.—It is somewhat alarming to be assailed with so many questions on the strength of a three days' visit to the Ruby Mines (laughter). I had no idea of writing a treatise on ruby mining, but thought that having visited the mines, I might give the Institute some idea of conditions there. Mining in limestone is entirely an economic question : it is possible to get rubies, but it costs too much. The native miners are wonderfully good at detecting stones. I have no doubt that they know small differences which they will not disclose to the casual visitor. I did not take note of the gravel pumps, but would get details and supply them later.

Mr. F. L. G. Simpson.—One point has been rather overlooked. I presume that the manufacture of re-constructed rubies is part of the business of the company, and that the process is a close secret. I would be glad if Mr. Simpson could give any information. (Laughter).

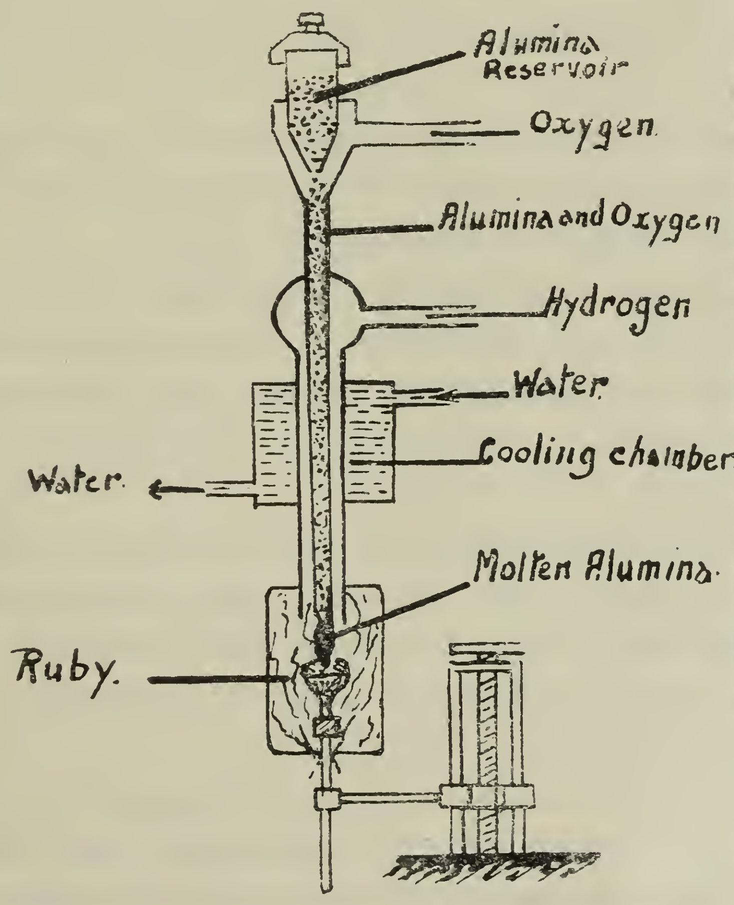
Mr. A. H. Morgan (Chief Engineer of the Burma Ruby Miners, Ld.) wrote in regard to the manufacture of re-constructed or synthetic rubies, that Guadin demonstrated in 1869 a method of preparing Corundum Gems, *i.e.* Rubies, Sapphires, and the Oriental Topaz, Amethyst, Emerald, etc., (*Les Pierres Precieuses, Jean Escard, Paris,* 1914.)

The process consisted simply of heating amorphous alumina in the flame of an Oxy-Hydrogen blow pipe. This Oxide melts into a sort of glass which on cooling gives a globule having the composition and properties of natural Corundum.

It is this process which, carried to perfection by Verneuil, has been the base of the manufacture of artificial rubies such as is practised to-day.

The industry has considerably developed since 1906 and in 1914 the production had reached an annual output of more than five million carats of gems.

The Verneuil furnace is shown in diagram below :—



VERNEUIL FURNACE

The alumina powder is prepared as follows :—

Dissolve 530 gms. of aluminate of ammonia in 4 litres of distilled water, add /150 cub. centms. of a solution consisting of 65 gms. per litre of alumin. of chrome and potass. The liquid is poured boiling in 7 litres of distilled water with 400 cub. ctms. of pure ammonia of 22°.

After about 1½ hours the gelatinous precipitate is spread on a cloth and, when well drained, washed by leaving it suspended in 8 litres of distilled water. It is again filtered and washed and spread as before. After being left several days on the cloth the alumina ceases to emit moisture. It is then dried and calcined at a cherry red heat, powdered and screened.

These conditions result in about 60 gms. of alumina containing 2·5 % of oxide of chrome in powder ready for the fusion which takes about 2½ hours.

To obtain sapphires of a good blue colour it is necessary to add 1·5 % ferric oxide and ·5 % titanic acid ; and, for yellow gems, oxide of nickel ; any colour or shade being obtained by the addition of appropriate oxides or their mixture.

These reconstructed or synthetic gems are identical in every respect with natural stones except that when magnified they show spherical bubbles and a fluidal or wavey structure against angular bubbles and a striated structure in the real articles.

"How does a native miner distinguish between real and artificial stones ?" This should be "native dealers" rather than "miners," for the artificial stones are only difficult to distinguish when cut.

It must be remembered that a native dealer is an expert and his eye has been trained and sense of perception quickened by his daily avocation and he is able to detect subtle nuances which are not apparent to other persons even when aided by typical examples.

The reconstructed ruby is a little too perfect and clear. Real rubies are practically never free from some defect, the structure is different and the real ruby almost always has, in some degree, a curious pearly lustre when viewed obliquely. This is called "silk" in the trade, and cannot be imitated.

The colour of a reconstructed ruby is slightly different by artificial light.

A native dealer will immediately identify an artificial stone, he cannot tell you why he knows it is not real, but he is scarcely ever deceived.

In regard to the pumping question, gravel pumps have been greatly improved of late years and are coming more into use. The makers are the Alluvials Machinery Co., the Wilfly Table Co. of London, Werf Conrad of Holland, and Thompsons of Castlemaine, Victoria, Aus. Their efficiency is low, being about half that of centrifugal pumps designed for water alone. The volume of water must be about twenty times that of the earth lifted. These pumps require the earth to be delivered at their suction either by a flow of water, or forced forward by a hydraulic jet. The delivery can be led through open launders or pipes to the point of discharge.

The height lifted should not be greater than eighty feet. If a greater height is required two or more sets in series must be used. Their capacity varies with the square of their size, *i.e.* a 6 inch pump will deliver 7,000 cub.ft. of water and 400 c.ft. of earth per hour while an 8 inch will deal with 14,000 c.ft. of water and 700 c.ft. of earth. When used for filling stopes the slurry is led down through a 6 in. bore hole, the lower end of the stope being closed and the overflow of the water being arranged well above the top.

EXCURSION TO KIDDERPUR DOCK EXTENSION.

During the afternoon the members of the Institute paid a visit to the Dock Extensions of the Port of Calcutta. At 3 P.M. they were welcomed by Mr. McGlashan, Chief Engineer, and his staff on the Swing Bridge at the entrance to the docks, and were afforded an entertaining and instructive afternoon. It was very apparent to all that the scheme is of wide importance, and will absorb a great deal of time and money. It is estimated that the soil excavated from the new King George's Docks will be 30 crores of cubic feet, and will be sufficient to reclaim 2 sq. miles of low land stretching from Garden Reach to the neighbourhood of Behala. It is intended to utilise this land for the railway approach and marshalling yard that will be necessary, and for ware-houses and similar purposes.

The work in hand at present is estimated to cost 764 lacs of rupees. This amount will provide for the construction of the entrance locks, dry docks, and five steamer berths, with their appurtenances of shades, cranes, roads, and railway tracks. The entrance lock will be 90 ft. in width, and will be capable of dealing with ships 695 ft. long, and of 32 ft. draft at lower tides. The two dry docks will be tandem, and of lengths 575 and 590 feet.

With the concurrence of the Consulting Engineer, Col. Cartwright Reid, it was decided to adopt the monolithic type of construction, owing to the great depths to which the excavations must be made. Most of the monoliths are 40 ft. square, built upon steel curbs each weighing 14½ tons. They are sunk by undermining by means of cranes and skips or Priestman grabs, which work in four vertical shafts provided in each monolith. The walls of the lock and dry docks will consist of a line of these monoliths, and the floor will be combination of monolith construction and brickwork.

The enormous quantity of bricks required for the work now in hand, about fifty lacs per annum for a period of six years, will be supplied from three brickworks that have been specially installed for the purpose.

The masonry and excavation work is being carried out departmentally by the Port Commissioners, under the direction of Mr. J. McGlashan, Chief Engineer, and is in direct charge of Mr. W. C. Ash, Officiating Deputy Chief Engineer, while the contracts for the steel works of the berths and curbs of the monoliths have been placed with Messrs. Braithwaite & Co.

EXPLANATION OF PLATE.

Plate 5. Plan of Port of Calcutta.

Annual Dinner.

The Annual dinner was held at Peliti's Restaurant at 8 P.M. when the chief guest of the evening was His Excellency the Governor of Bengal. The President, Dr. Fermor, was in the chair and the following members and guests were present :—

Messrs. W. J. Alcock, H. S. Allen, W. R. Bell, Dr. C. A. Bentley, J. Brown, J. Bullock, C. B. Chartres, G. Crawford, H. Crookshank, D. P. Davies. A. W. Dods, W. Gibbs, T. S. Gibson, W. M. Glover. S. H. Harman. E. S. Hoernle, Alec B. Hughes, G. C. Leach, H. J. McGee, D. D. Macdonald, G. W. Marshall, E. D McDermott, Geo. Miller. K. Mirza, J. A. Oliver, E. Parsons, D. Penman, J. R. Phillips, J. B. Pratt, R. Purdy, E. H. Roberton, S. H. Seddon, R. R. Simpson, F. L. G. Simpson, A. J. Simpson, Major E. S. Staples, H. M. Tarlton, C. B. Templeman, J. Thomas, Dr. G. W. Thompson, G. H. Tipper, J. B. Wardlaw, A. Webster, G. C. Webster, C. Winfield, A. C. Wright.

The Guests of the Institute were :—

His Excellency Lord Ronaldshay, Governor of Bengal; The Hon'ble Mr. J. H. Kerr, C.S I., C.I.E., I.C.S., The Hon'ble Nawab Syed Nawab Ali Chowdhury Khan Bahadur ; Mr. C. D. M. Hindley, Agent, East Indian Railway ; Sir G. C. Godfrey, Kt., Agent, Bengal Nagpur Railway ; Sir R. N. Mukerji, K.C.I.E. ; Mr. C. J. Freke, Director General, Commercial Intelligence ; and the Director of Industries, Bengal.

After the Royal toast the President submitted His Excellency the Governor. He said :—

Gentlemen.—I have before me to-night the very pleasant task of proposing the health of our chief guest, His Excellency Lord Ronaldshay, Governor of Bengal. I cannot, however, claim any extensive experience of after-dinner speaking, and consequently I cannot disguise from you that I approach this task with a certain amount of anxiety, which, however, is dispelled by the realisation of our distinguished guest's genial personality.

Lord Ronaldshay, on the other hand, has had a wide experience of this pastime, and in particular of replying to the toast of his own health: for our guest is a man whom many people delight to honour. This thought increases my difficulty, for I realise that I must not hope to strike an original note.

Perhaps the first thought I may express on your behalf is a feeling of gratitude to our guest for consenting to honour us with his presence this evening. Our Institute was founded in 1906, when Sir Andrew Fraser was Lieutenant-Governor of Bengal, and at intervals at our annual dinners we have been privileged to entertain each of the rulers of this province—Sir Andrew Fraser, Sir William Duke, and Lord Carmichael. We should have been grieved, Sir, had you departed from India without having afforded us the opportunity of extending to you similar hospitality.

In Bengal, Lord Ronaldshay rules a vast and wealthy province, wealthy not so much in revenue to the Local Government as in natural productions and in industry and commerce. Calcutta is nominally the capital of Bengal: actually it is the chief nerve-centre, the centre of gravity, of the Indian Empire. A glance at the map of India will enforce this point. From Calcutta the traveller can journey direct without change to all the important capitals of India—to Patna, the most ancient of all, to Lucknow, Delhi, Lahore, Nagpur, Bombay, Madras and Rangoon, and with one change to Quetta. By its position on the Gangetic delta, Calcutta is the natural port through which the coal of Bihar and Orissa, and

Bengal, the jute of Bengal, and the tea of Assam, with many other valuable products, flow for export. Calcutta is consequently the principal commercial and business city of India, with the largest total export and import trade, and the largest banking turn over. It is also the headquarters of several scientific departments of the Government of India, the locus of the Indian Museum, and of the premier learned society of India, the Asiatic Society of Bengal; it is consequently the possessor of some of the finest libraries of Asia, including the Imperial Library, the libraries of the scientific departments, and of the Asiatic Society of Bengal. In fact, there is little doubt that Calcutta can be accurately described as the centre of scientific and other research in India.

It is, therefore, no small honour to be, not only Governor of Bengal, but the ruler in the capital of commerce, business, and learning in India.

We all know that, during his tenure of office, now alas! drawing to a close, Lord Ronaldshay has had thrust upon him greater responsibility than has, perhaps, fallen to the lot of any previous ruler of this province; we are all aware how skilfully our guest has steered the barque of State through the first portions of her voyage on the new unchartered sea of reforms, and how he has succeeded in maintaining a straight course in spite of many adverse winds and cross currents; and we all feel that this is a fitting opportunity to congratulate the helmsman on his success. (hear, hear).

Let us, therefore, recall that not only are we entertaining as our guest the ruler of this great province, but also the principal and chief host therein; one who, happily and generously, through a period of five years, both here and in Darjeeling, has dispensed profuse and abounding hospitality to a very large number of delighted guests—Princes, peers and people.

Perhaps I have now succeeded in inducing our guest to ruminate upon the pleasure he has given to others and, let us hope, upon the reciprocal pleasure he has himself experienced. I hope that, without disturbing the pleasant reveries of our guest, I may be permitted to suggest to you, my other fellow-diners, additional thoughts. Let us, seated in this festive hall, in the nerve ganglion of India, allow our collective imagination to traverse the railways of the country in turn to all the points of the compass. I think you will agree that we find it difficult to call a halt on reaching the many capitals I have already named. Instead, our fancy pursues its natural course to the frontiers of the Empire, beyond which lie the many countries of Asia. This leads to the thought that in entertaining Lord Ronaldshay we are entertaining not only a great ruler, but a great traveller; for, before our guest came to rule in Bengal, he had visited nearly all the countries of Asia and had acquired thereby a deep understanding of Asiatic peoples.

A well-known story relates that in the somewhat distant past—as human history goes—there was once in one of these countries, a youth named Aladdin, who, as you know, has been but recently re-incarnated in Bengal—still youthful. I must observe, Your Excellency, that you have not succeeded in escaping the Fate that Abanazar, the sorcerer, in his maledictions, called down upon Aladdin, the Fate of being Governor of Bengal. (Laughter) From this I deduce that you cannot be the present possessor of Aladdin's wonderful lamp. In fact, I have myself seen you gaze upon it from afar, with a look perhaps of longing in your eyes. That Abanazar's views on the horror of the fate that is yours, Sir, have not been confirmed, as far as I am able to judge, by your own experience, is perhaps due to your possession of another magic lamp—the lamp of geniality; a lamp that you have kept so constantly trimmed during the past five years, and which, as you have rubbed it on occasion, has endowed you with the ability to solve many problems where personal genius is the principal factor.

I have deliberately refrained, Sir, from introducing into my remarks technical matters, chiefly because my object is to express our hospitable feelings, but partly because I had this morning a suitable opportunity of discussing such matters. To one subject, however, I may refer as affording the most tangible expression of the benefits of geology in Calcutta. Four weeks ago many of us had the pleasure of listening to an eloquent address from you, Sir, on the occasion of the opening of the Victoria Memorial Hall. You alluded, Sir, to the meaning of this beautiful memorial and related the history of the undertaking. You were possibly not aware, Sir, that we geologists were responsible for the selection of the marble with which the memorial has been constructed, for the use of Indian marble instead of foreign, as was the first intention. Perhaps I may permit myself to play for a moment with the fancy that by our particular selection of marble we geologists have provided a practical refutation of somewhat cynical suggestion I made in jest in my address this morning when I referred to the dependence of human history upon geological history, and suggested, though not in words, that men are as mere microbes crawling on the face of the earth. The marble used in the Victoria Memorial belongs to the most ancient geological formation, both in India and, as far as we know, in the whole world. By erecting this memorial of Archaean marble upon the alluvium of Bengal, the youngest of all the geological formations, Man has achieved a feat impossible to Nature; he has superposed the Archaean upon the Recent.

Gentlemen, I am now approaching rapidly the moment at which I shall ask you to show your admiration for our guest. As printed, my toast is that of Lord Ronaldshay alone; but I feel that we cannot refrain from conjoining with his name that of the great hostess, Lady Ronaldshay, to whom, on your behalf, I take this opportunity of wishing a happy return to the old country.

Gentlemen, I give you the toast of the great traveller, ruler, and host, His Excellency Lord Ronaldshay, Governor of Bengal, and of Lady Ronaldshay (*Applause.*)

His Excellency, responding, said:—

First of all let me thank you for your kind invitation to me to dine with you this evening; and then let me thank you for the cordiality with which you have drunk the toast proposed in so charming a speech by your Chairman.

While it is hardly necessary to tell you that I am myself no geologist, I am very much alive to the utility of the labours of the geologist to mankind. I might, indeed, have pointed out the various ways in which he is able to place his expert knowledge at the disposal of man to his great advantage, over and above the obvious one of informing him where he will find the minerals which play so large a part in the life of man at the present day. I should have been delighted to make this contribution towards justifying your existence had it not been for the fact that Dr. Fermor by his address this morning has rendered any such attempt on my part altogether superfluous. No one who listened to his comprehensive and lucid exposition as President of the Mining and Geological Institute can be left in any doubt that, supposing the geologist were by some strange vagary of fate to be eliminated from our midst—which God forbid—(*laughter*) —civilized existence would be brought to a standstill. I did not always realise this. Once upon a time as a member of the Public Services Commission I had to wrestle with such thorny problems as the pay and prospects of the Services in India and amongst them of the Geological Survey, (*laughter*). In the course of examining witnesses I asked an innocent—though as I soon realised a very foolish question— namely, might not a day come when the Geological Survey would be completed and the need for further retention of the Service cease? (*Renewed laughter.*) Well, some of you are geologists and I need not repeat the answer which I received. It may, perhaps, be counted unto us for righteousness that we recommended some improvement in the pay and prospects of the Service including, if my memory serves me, a special pension for the Director, (*Applause and laughter.*)

In the course of his remarks this evening Dr. Fermor has stated that in Bengal I rule over a vast and wealthy province, though he took the wise precaution of qualifying this statement by pointing out that it was wealthy, not so much in revenue to the local Government as in natural productions and in industry and commerce. How true this qualification is must be obvious to any one who has followed the debates in the Bengal Legislative Council during the past few days. I believe the wealth of India in natural resources is great; but that wealth is potential rather than actual. And one of the most important problems with which India is faced is that of converting its potential wealth into actual wealth. Economists tell one that a pretty fair index of the industrial development of a country is to be found in the extent of its production of steel. Well, the geologist knows how great are the iron-ore deposits of Orissa and he knows how high is the quality of the ore. I believe there are millions of tons of ore of far higher grade on the average than the iron-ores of Great Britain awaiting the pick and shovel of the miner. And it is worth while considering, therefore, what are the prospects of a big expansion in the Indian steel industry in the near future. It cannot be said that much had been done up to the time when many people and many things were shaken out of a state of apathy by the great war. Certain ancient records inform us that in the year 1774 a certain Suetonius Grant Heatly obtained permission from the Government of Warren Hastings to work the coal of Birbhum and that an Indian gentleman of the name of Indra Narayan Sarma obtained leave to work the iron-ore deposits in the same district. The result of the very laudable enterprise of these gentlemen unfortunately lies buried in obscurity.

Almost exactly a hundred years later, in 1875 the foundation was laid of the undertaking which is now known as the Bengal Iron Company's Works at Kulti which I had the pleasure of visiting last year. Rather later, steel works on a small scale were put down by the Government Gun and Shell Factory at Cossipore and by the East Indian Railway at Jamalpur. And, of course, there are the Tata Works of more recent growth which received valuable assistance in its earlier years in the shape of a standing order from Government for 20,000 tons of steel rails a year. But, as I have said, it was the war which really gave to the iron and steel industry in India the greatest impetus which it has so far received. And judging by the new enterprises which are coming into existence, this impetus has by no means spent itself. The Indian Iron and Steel Company are erecting works at Hirapur on a scale comparable with those of the Tata Company. Again, at Ondal in the Raniganj district, a company entitled Indian Steels, Ltd., is laying down electric furnaces for the production of steel suitable for tool and machine construction. At Rupnarainpur the Kirtyanand Iron and Steel Company have erected plant for the production of steel castings on a large scale. And I believe that an Indian firm is also erecting electric furnaces for the production of steel castings in Calcutta. It looks, therefore, as if we were on the eve of a considerable industrial advance. On the other hand, it would be unwise to minimise the difficulties in the way.

One of the greatest difficulties is the absence of suitable labour. The Indian labourer is still at heart an agriculturist; and he shows a strong tendency to regard factory labour as a means of putting in time during the slack season on the land (*hear, hear.*) It is not surprising, consequently, that he falls far short of his fellow labourer in Europe and America in efficiency. Compare, for example, the output of coal per man employed, in the case of India and the United States of America where the coal seams are of much the same thickness. In the latter country the amount of coal produced *per* person employed above and below ground is about 800 tons a year. In India in 1920 it was 100 tons only. This was less than the previous year when each person was responsible for an output of 117 tons; a fact which suggests that labour, naturally inefficient, was rendered more so by the disturbances due to political unrest. This last factor is one which may have a disastrous effect upon the industrial development of the country in the immediate future, for not only may it demoralise labour, but it may frighten away the capital without which no great expansion of industry, and consequently no great increase of wealth, can possibly take place. Let us hope that the present unrest is a passing phase, and that ere long the country will settle down to the systematic development of its resources upon which the prosperity of its people must so largely depend (*applause.*)

"The Mineral Industries of India" was submitted by the Hon. the Nawab Syed Nawab Ali Chaudhury Khan Bahadur. He said :—

There is in India, even in these somewhat unsettled times, which we, like so many parts of the world, have not escaped, one point on which all parties, be they Indian or European, will agree.

This is the great importance to a country of its mineral industries, and especially so to India, where the high proportion of the population dependent on agriculture and thus on the nature of the monsoon, make it particularly desirable that fields of employment not so dependent, such as the mining industries, should be developed as far as possible.

I would only mention two of the mineral industries of India to show how important they are to the life and well being of the country.

To take the coal industry, the value of whose product averages about 40 % of the total mineral production of India—it is difficult to conceive India importing all its coal from foreign countries. Railway travelling would increase in cost, the price of cloth would rise and a general increase in the cost of living would take place.

In fact, the prosperity, the general as well as the industrial prosperity of a country depends on its power-supply of which coal forms, perhaps, the most convenient.

To alter a truism, the more ample and the cheaper the coal supply of India, the better will be the economic position of the humblest ryot in the country.

Then again, the iron and steel industry of India—yet in its infancy—is destined to produce all the iron and steel requirements of India and to export to other countries. No country has better iron-ores and no country can produce more cheaply.

To a gathering consisting largely of engineers, I need not point out the value to the country of this when it takes place. It means railways cheaper to construct, buildings cheaper to build, and an industry absorbing large quantities of skilled and unskilled labour.

If coal be considered as the industrial life blood of a country, iron and steel are the veins and arteries by which such blood permeates to the remote parts of the body industrial.

No industry could be more swadeshi than these two, which exist to produce in India, and to prevent importation of the two material bases of industrial prosperity.

You will note gentlemen, I say material bases, as intimately connected with material prosperity, there are usually essentials not material in the same sense.

Two such essentials I would mention in connection with the mineral industries of India, are mining education and relations with labour and they are two points on which Government and the industry are likely to touch frequently in the coming years.

As regards mining education all are agreed on the necessity and desirability of affording cheap and good mining education for youths in this country and neither

Government nor the mineral industries should rest until there is provided as good mining education as can be obtained anywhere in the world.

Ideals are often held down by material difficulties, and unfortunately, the financial position of India makes, at present, economy an over-riding consideration. This, I trust will not last for ever and the Government of Bengal are fully alive to the educational needs of the mineral industries.

As regards labour, the views expressed by the Chairman of the Indian Mining Association to the recent Trades Union Congress point out a policy which, if followed, should lead to good and peaceful relations between the employers and employed in the mineral industries in India.

The employers state, that they recognise and sympathise with the aspirations of labour for better living and economic conditions, but point out that these can only be realised by labour becoming more efficient, and that mere increases in wages, leading to a lower efficiency and resultant lower output, would cripple the industry and recoil on the heads of the workers.

If both sides realise, as I am sure they will, that they have duties and responsibilities to the country as a whole, in addition to the mere earning of profits or wages, we shall avoid the mistakes and industrial strife of older countries (*applause*.)

Mr. C. B. Chartres, responding, said :--

I feel that I owe the honour of being asked to reply to this toast to the fact that I am connected with one of the new companies which has recently embarked in the metallurgical industry and when I look around me and see several speakers renowned for their eloquence on post-prandial—and other—occasions I think it well to warn you that I am almost as great a novice at speech-making as is my company in the art of iron manufacture, but just as a company will not be too critical about a works manager's results in the first cast of pig iron from a new blast furnace, so I crave your indulgence with regard to my outpourings to-night.

I wish to thank you, Sir, for the very kind manner in which you have proposed the toast.

The metallurgical industry is an enormous subject, of which—in comparison with some other countries—only the fringe has so far been touched in India. Broadly speaking it may be said to embrace on the one hand coal mining and coke manufacture and on the other hand metal mining, reduction, refining and manufacture of the various metals.

The largest and most important branch of the industry is undoubtedly the manufacture of iron and steel. No other metal has so profoundly influenced the history of the world as iron. It has given its name to an epoch in the story of the world which is not yet ended—the iron age. Some of the learned members the latter half of this Institution—though it seems to me that geologists should really precede miners—might tell you that the Palaeozoic or the Cainozoic or some other zoic period had the greatest effect on the world's history, but I think the claims of iron and steel predominate. Think what they have done for the civilization of the world.

They are used in ships, trains, motor cars and all means of locomotion, in road bridges, in beams for our houses, in implements for growing, preparing and cooking our food, in machinery for making our clothes and in countless other ways for the benefit of mankind. The advance of civilization throughout the world was very rapid from the beginning of the iron age, and we know to our cost that eight years ago the people of a great European country were boasting of their culture—but in their case the word was spelled with a K—and that the present chaos in the trade of the world is due to their misuse of the advantages which the iron age bestowed on them. On the other hand in India at present we have a body of voluble and vociferous individuals who think it would be better for this country to revert to the culture—in this case spelt with a C—of 2000 years ago when iron though not unknown was not in common use—but I notice that the leader and many of the lieutenants of this party in order to give the country the benefit of their sapient wisdom make frequent and constant use for themselves and for their words of the most rapid means of transport that the iron age can provide.

I think we may take it therefore that in spite of the disastrous results of culture with a K, and in spite of the idealistic yearnings for old fashioned culture with a C, the iron and other metallurgical industries will go on being more and more necessary for the needs of India.

Let us then consider briefly some of the outstanding needs and requirements of these industries in India to-day. India was famous in the past for her gems and precious metals, but the gold mines in Mysore State are the only ones working to any extent to-day. They have been splendidly developed by the help of cheap electric power transmitted nearly 100 miles across country. Gold propositions nearer Calcutta have attracted speculators at different times, but so far the mythical parent lode has not been located. Copper-ore also exists in many places with rich pockets which have been worked on a small scale for generations, but to-day there is a large works at Rakha turning out refined copper for the Indian market and I feel sure we all wish this pioneer company success. Silver, lead and zinc are being mined in the Shan States of Burma from one of the richest mines in the world. Fire-clay and pottery works, mica and manganese-ore provide well-known and important businesses; but it is when we come to iron and its black sister coal that we reach the most important metallurgical industries in India. The development and the requirements of the coal trade are no new subject at this board as at most of our dinners one or more representatives of this industry have taken the opportunity to shout Wagons. They still have reason to shout. Let us see how the iron industry stands in this respect.

Iron has been smelted in India for probably some hundreds of years by crude methods on a very small scale, as iron-ore is found in large quantities in many different parts of the country. High grade deposits in the Salem District of Southern India are well known, but their position being remote from the seaboard and from suitable coal has so far precluded their successful smelting.

In 1908 investigation of the Singhbhum deposits proved a high grade ore, and more recent study of this district of the Province of Bihar and Orissa and the neighbouring Feudatory States has disclosed one of the finest iron-ore fields in the whole world. The ore can be mined to average about 64 % iron and it is interesting to compare this with the ore fields of other countries. English ores run from 28 % to 32 % iron, Spanish ores 49 % and the famous Lake Superior ores of America 51 %. Thus Indian Companies using Singhbhum ore start with a considerable advantage. The reduction of iron-ore however requires a good quality of hard coke, low in ash and free from phosphorus, and in this respect India is not so well placed. The only good coking coal so far mined in India comes from the Jharia field, and for iron and steel making this coal is an absolute essential at present. Unfortunately for iron smelters, the railways seem to think this coal also indispensable for locomotive purposes with the result that most of the wagons which can be moved in and out of this Jharia field are on railway account and it is impossible for the iron and steel works to get enough of the only quality of coal which they can use.

Now, Gentlemen, this seems to me an anomaly which should not be allowed to exist a day longer than is absolutely necessary. There are other coal-fields in India which can be developed to supply all the loco coal required if the railways will but extend their lines to those new fields. It may be that these new coal-fields will also provide coking coal but that is problematical, and in view of the undoubted importance to India of a well established iron industry I submit that every possible step should be taken by Government to conserve the known deposits of coking coal in Jharia for the use of this industry.

The political changes in this country are not going to be without their effect on the iron industry, as one of the first of the doubtful delights of democracy is a more expensive Government and in order to make up their deficiencies the Governments of the two provinces with which this industry is mainly concerned are understood to be contemplating a levy per ton on our raw materials, coal and iron-ore. I contend that this form of tax is a mistake. The right place to tax an industry is on its profits, but here in India we are apparently going to have the Central Government pouncing on its share of the profits (when there are any) and the Local Governments taking their toll even if there are none. This does not strike me as a good scheme for encouraging industry, and, adapting an old adage, I would say in all earnestness to the Local Governments: Do not kill the young Metallurgical Goose. It may lay a golden egg. Give it a chance to lay and then take a bit of the egg. I suggest that it would be much better for the country if all the Local Governments would combine and insist on having a larger share of the tax on profits which they collect for the Central Government.

Calcutta has recently had a visit from another of the many Commissions which the Government of India seems to delight in appointing and when I had the privilege of appearing before the Fiscal Commission as one of the representatives of the metallurgical industry to point out the need of some protection to allow this industry to train up Indians for the work which is as yet strange to them a leading Calcutta paper next morning inferred that we were bloated capitalists seeking to get rich at the expense of the community. Well, we may be capitalists, but I think any one who studies the market quotations of iron and steel company shares would scarcely call us bloated.

The crying need of industries in India to-day is for more skilled Indian labour to enable these industries to compete with foreign countries, where labour has been trained for generations in the metallurgical trades and has an inherited instinct for the work. It will take one or two decades to develop this instinct in India, but meanwhile much can be done by suitable technical education followed by practical training, and I am glad to note the Local Governments' interest in the former. They will find the large metallurgical companies only too willing to do their part in providing the training, for surely the result is worth working for. When one considers the better pay, better housing and better living arrangements which these large companies provide for their workers it will be seen that the extension of the metallurgical industry while making the country more self-supporting —and bringing wealth to the local Governments—will provide scope for intelligent work under prosperours conditions for a large body of Indians and apart from the employment of skilled and unskilled workers it provides a field for the training of the educated Indian youth enabling him eventually to take his place in the world as a metallurgist and thus ensure India's being able to provide for the iron and steel industry from her own peoples.

In a few well chosen words Mr. H. M. Tarlton profferred "The Guests."

Sir R. N. Mookerjee replying said:—

I rise to respond to the toast so briefly and eloquently proposed by Mr. Tarlton and so cordially received by you all. Your Institute has gained a reputation in hospitality since its inception. Once a year you entertain large number of guests comprising men of various grades and status in life, and it seems you are extending your hospitality every year. Since the last two years you have been inviting Indians to your annual function beginning with the highest aristocracy in Bengal and coming down to an ordinary craftsman, and I may be permitted to observe, although it is against my own interests, that in your steep descent you are taking some risks. However, allow me to thank you heartily on behalf of myself and my other fellow guests for your sumptuous hospitality and for the opportunity you have given us of listening to some interesting speeches.

Gentlemen, your Institute is one of the most useful organisations in the country. The best men of science in geology and mineralogy in India are on your roll of membership. The wealth of nations depends obviously less on the possession of mineral resources than on the ability and activity of the men who exploit them. The development of Indian industries to a large extent follows the achievements of geologists and mineralogists. I need hardly mention to an assembly like this that coal is by far the most important of all the mineral products. Next to coal in importance is iron. The existence of extensive coal, iron and manganese deposits in India has profoundly influenced the course of her industrial development, and we look to this Institute to continue to play a leading and active part in her industrial growth. No nation can command the respect of its neighbours that does not fully develop its resources in raw material. It has been said that a nation that makes fullest use of its resources in coal and iron can rule the world. Signs are not wanting that India is beginning to realise the stern truth of this fact. It is true that industrial development has not the glamour of political advancement, but the practical propaganda of your Institute unites all parties—officials, non-officials, Europeans, Indians—and I hope to see it spread with ever-increasing force to make both Government and the people of the country appreciate the intrinsic value of the solid and unobtrusive good work that is being done by you.

Gentlemen, your Institute so fairly started sixteen years ago has had a continuous and most useful career. It has grown with the growth of the mineral industry of India; it has been advancing with the advance of science and is now firmly established in the confidence of the industrial and commercial men of India—ever useful, ever fruitful in the cause of the development and enlightenment of industries. Gentlemen, I thank you again for your kind hospitality.

Submitting "The President," Mr. George Miller said :—

Your Excellency, Mr. President and Gentlemen,—It is my pleasant duty this evening to propose the health of our newly elected President, and in offering him my congratulations on the compliment paid to him by the members of this Institute. I also congratulate the members on the very excellent selection made by them.

Dr. Fermor has been associated with this Institute from its formation being one of the original members and he has given to it his untiring and ungrudged support at all times.

His genial and unassuming manner makes his presence a source of pleasure to those associated with him.

He has attained high distinction in his profession and was awarded the Bigsby Medal in 1921, by the Geological Society of London for eminent services rendered to geology and two of our worthy past Presidents, Sir Thos. H. Holland and Sir. Henry Hubert Hayden now have gained the same award.

This Institute and the industries of which it is representative are greatly indebted to these men for the bond of friendship formed between the scientific and practical worker by them through the medium of this Institute and I feel sure that that bond has been closer knit in the selection of Dr. Fermor as our President.

Eminent services have been rendered to this country by Dr. Fermor and the profession to which he has the honour to belong, in making known the enormous mineral wealth that this country contains.

In research work Dr. Fermor has attained a high place as his work on manganese in India testifies, and the discovery of eight entirely new minerals stands to his credit. The value of the work done by the Geological Survey of India cannot be over-estimated. The metallurgist and mining engineer whose business it is to develop the minerals discovered and mapped out by the geologist can fully realise the value of such work and the remarkable accuracy which is attained in it.

I have every confidence that the Institute will have an interesting and profitable year under the able pilotage of Dr. Fermor and I beg now to ask Your Excellency and Gentlemen to drink to the health of our President, Dr. L. L. Fermor.

Dr. Fermor, responding, said: It is with a feeling of considerable embarrassment that I rise to reply to the toast so kindly proposed by Mr. Miller. I hope I shall be able to justify the expectations he has aroused in you by my assumption of the direction of the Institute during the coming year. I think it will be more tactful on my part to divert your attention from myself and direct it towards our honorary secretary (*applause*). Our honorary secretary, Mr. Roberton, is really the man who does the most work for the Institute. This evening he has chosen an unassuming position—I cannot even see where he is (*laughter*). I know he has had great anxiety in arranging this meeting to-day and I really think you owe him more thanks than to any President (*applause*).

Mr. Roberton, in response to persistent cries for a speech, said: Your Excellency, Mr. President and Gentlemen: On a former occasion an honorary secretary—my immediate predecessor, as a matter of fact—was persuaded or rather coerced—(*laughter*)—to get up and make a speech. He made the briefest speech that I have ever heard. I have already exceeded it in length and I will not exceed it any more than I can help. Thank you, Mr. President (*applause and laughter.*)

During the proceedings His Excellency presented the Institute medal awards to Mr. R. R. Simpson, Dr. G. W. Thompson, and Mr. J. Thomas.

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Central Provinces and Berar Branch.

MEETING AT KAMPTEE.

Held on Tuesday, the 31st January, 1922.

The Inaugural Meeting of the Central Provinces and Berar Branch of the Institute was held at Kamptee, the headquarters of the manganese mining industry of the Central Provinces, on the 31st January. Among the members present were The Hon'ble Mr. B. P. Standen, Messrs. W. H. Clark, R. S. Davies, H. D. Coggan, H. R. Holmes, L. H. Bartlett, H. W. Hallifax, W. P. Jenkin, A. S. Lindley, W. H. Berry, W. H. Bennetts, R. Harvey, J. C. Jenkins and J. F. Spedding.

Mr. H. D. Coggan, one of the Vice-Presidents of the Institute, presided, and in the course of his address congratulated the members on the formation of the branch and on the thoroughly representative nature of its membership, which included practically all those engaged in the coal and manganese mining industries of the Central Provinces who were eligible for membership, including the Revenue and Finance Member of the Government, who takes a keen interest in all matters connected with the mineral industries of the Province. Mr. Coggan referred to the reasons for which the branch had been formed, and indicated the channels in which the activities of the branch might be directed and the lines on which papers might be written. He regretted the unavoidable absence of papers for discussion at this meeting owing to the short notice at which the branch had been formed, but said that certain papers were already in preparation and hoped that the members would at no distant date have the opportunity of discussing them and that their branch of the Institute would build up an interesting and instructive record of the scientific as well as the practical side of mining in the Central Provinces.

Mr. L. H. Bartlett was elected as Honorary Secretary of the Branch for the year.

INAUGURAL DINNER.

A dinner was held the same night when the principal guest was His Excellency the Governor of the Central Provinces. Among the other guests present were Messrs. R. M. King, H. R. Crosthwaite, C. J. Irwin, E. Gordon, C. K. Seaman, H. Copley, H. M. Hance, G. E. Bright, G. N. Frankau, A. Gordon Gray, S. Coxon, and Capt. E. B. Swinton.

After the toasts of H.M. The King-Emperor and H.R.H. The Prince of Wales had been duly honoured, Mr. H. D. Coggan proposed the toast of "His Excellency the Governor." He said that His Excellency had always shown a keen and kindly interest in all matters concerning the development of the mineral resources of the Province, and that his presence among them on this occasion would be an encouragement to them in their efforts to make the newly formed branch of the Institute a success. In the course of his speech Mr. Coggan referred to the criticism of which the export of manganese-ore as raw material, instead of in its converted form of ferro-manganese, had from time to time been made the subject. He said that there was a great deal to be said for and against this, and although they would all like to see more of the mineral utilised in this country, it should be borne in mind that high grade as it was, there were certain inherent defects in the ore itself as well as in the fuel available, that made it unsuitable for the production of the higher grades of ferro-manganese, without the admixture of manganese from other countries; and that if any embargo were to be placed on its export, Indian manganese might find itself supplanted in the markets of the world and have difficulty in recovering its position.

Referring to the question of the conservation of manganese-ore for future generations, Mr. Coggan said that when it was considered that India supplied, without any great effort, one-third of the world's demand, and that it would mean the establishment in India of the equivalent of one-third of the steel and ferro-manganese furnaces of the world before her normal output could be utilised locally, it would be realised how remote was the danger of depleting the manganese resources of the country. Then again it was not always wise to look too far ahead in view of the possibility of the discovery of a substitute for manganese, for with all they had recently heard about synthetic gold, the production of pearls of great price by the simple process of inserting grains of sand in the vitals of the unoffending oyster, and in view of the possible discovery of the philosophers' stone, they might perhaps be excused if they made hay while the sun shines. In concluding, Mr. Coggan expressed the great pleasure they felt at His Excellency's presence among them and said that they looked upon his presence at their first gathering as a happy augury for the success of the Branch. His Excellency stood to them for the Government with whose encouragement and help they had been able to bring the mineral industries of these Provinces to their present state of development, and with whose continued help they hoped to maintain it.

His Excellency Sir Frank Sly, in responding, thanked the members of the Institute for the cordial manner in which they had received the toast of the Government. He said that it gave him great pleasure to be present at the first meeting of the local branch, that he hoped to hear a good deal of their activities in the future, and expressed the wish that a copy of every paper read by the branch should be sent to Government. His Excellency emphasised the importance of scientific investigation of the mineral resources of the province; he said that the mines had materially improved the condition of large numbers of the people of the province by affording them remunerative employment; he acknowledged the ready response made by mine-owners to the appeals of Government for the increased employment of labour in times of famine and scarcity, and said that if there was anything further that Government could do to assist in the development of the mineral industries of the province, he hoped the branch would inform the Government. In conclusion, His Excellency cordially wished the newly formed branch of the Institute every success.

The Hon'ble Mr. B. P. Standen in proposing "The Mineral Industries of the Central Provinces and Berar" said that he was not qualified to speak either as a geologist or a mining engineer, but being in charge of the law regulating the administration of mining in the Central Provinces, he was proud to say that the mining industry had made great strides in the course of the past twenty-three years, and that the mines helped a great deal in relieving the situation in times of famine and scarcity by providing sufficient work for labourers, thus assisting Government to save money which could be usefully employed in furthering the material and intellectual progress of the province.

Touching on the question of mining education, Mr. Standen said that although Indian capital is being attracted to mining, there was no indication that the class of educated young Indians had turned its attention to the profession of mining engineering; Government were anxious to do all they could to help in this direction, but although the Central Provinces Government had for many years past offered a scholarship for the training of students at the Sibpur Mining School, not a single application had so far been received. Three more scholarships will be offered, tenable at the Dhanbad School of Mining. Mr. Standen also said that in order to prevent the waste of the mineral wealth of the province by unsystematic working on the part of small concessionaires Government had considered it necessary to impose certain restrictions on the grant of certificates of approval, but it was desired to hinder as little as possible the flow of capital to the mining industry, and Government is considering, with expert advice, what are the minimum restrictions which must be placed on the right of the public to prospect.

Mr. W. H. Clark responding, in a most interesting speech, which may justly be styled "The Romance of Manganese in India," sketched the birth and growth of the manganese mining industry in the Central Provinces; he said that the first trial shipment of the ore to the United Kingdom made in 1899 by Mr. H. G. Turner, the pioneer of the industry in India, lay for several months without a buyer! The following year 50,000 tons of the Central Provinces ore found a market and seven years later the production reached nearly 700,000 tons. Mr Clark humorously described the early difficulties of transport from the mines to the railway, and contrasted the primitive means then employed with the present system of railways and tramways that served the mines. He paid a tribute to the part played by the earlier geologists in the discovery of the manganese deposits of the province, and to their successors who had since thrown much valuable light on their mode of occurrence, nature and extent.

Mr. R. S. Davies replied in brief but suitable terms on behalf of the coal mining industry of the provinces.

Mr. H. R. Holmes in a felicitous speech gave the toast of "Our Guests," referring to many of those present, who in their official capacity had done much to encourage and assist the development of the industry. He referred to their old friend Sir Charles Low, who during his time in the Central Province had taken a particularly keen interest in mining matters and to whose interest they owed, in a large measure, the formation in 1907 of the Central Provinces and Berar Mining Association, a body which represented all the important mining interests in these provinces, and which had been given the right of sending its own representative to the Legislative Council.

Mr. R. M. King, I.C.S., replying on behalf of the guests, thanked the members for their hospitality and wished the local branch every success.

In response to insistent demands Mr. H. M. Hance in a humorous speech gave his views on the question of dead rents and royalties and Mr. A. S. Lindley gave an interesting discourse on the scientific side of the industry.

* * *

Fig. 1.

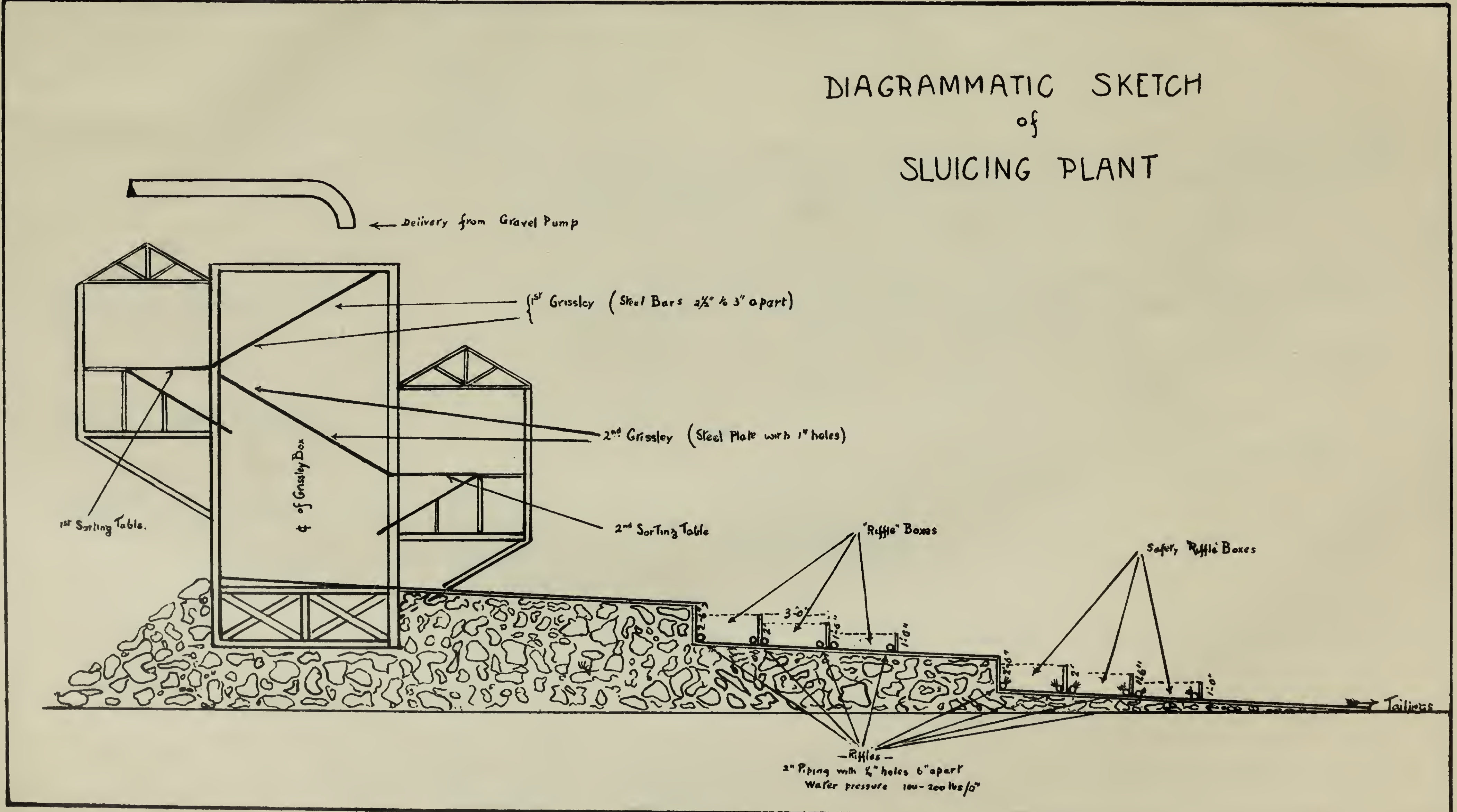
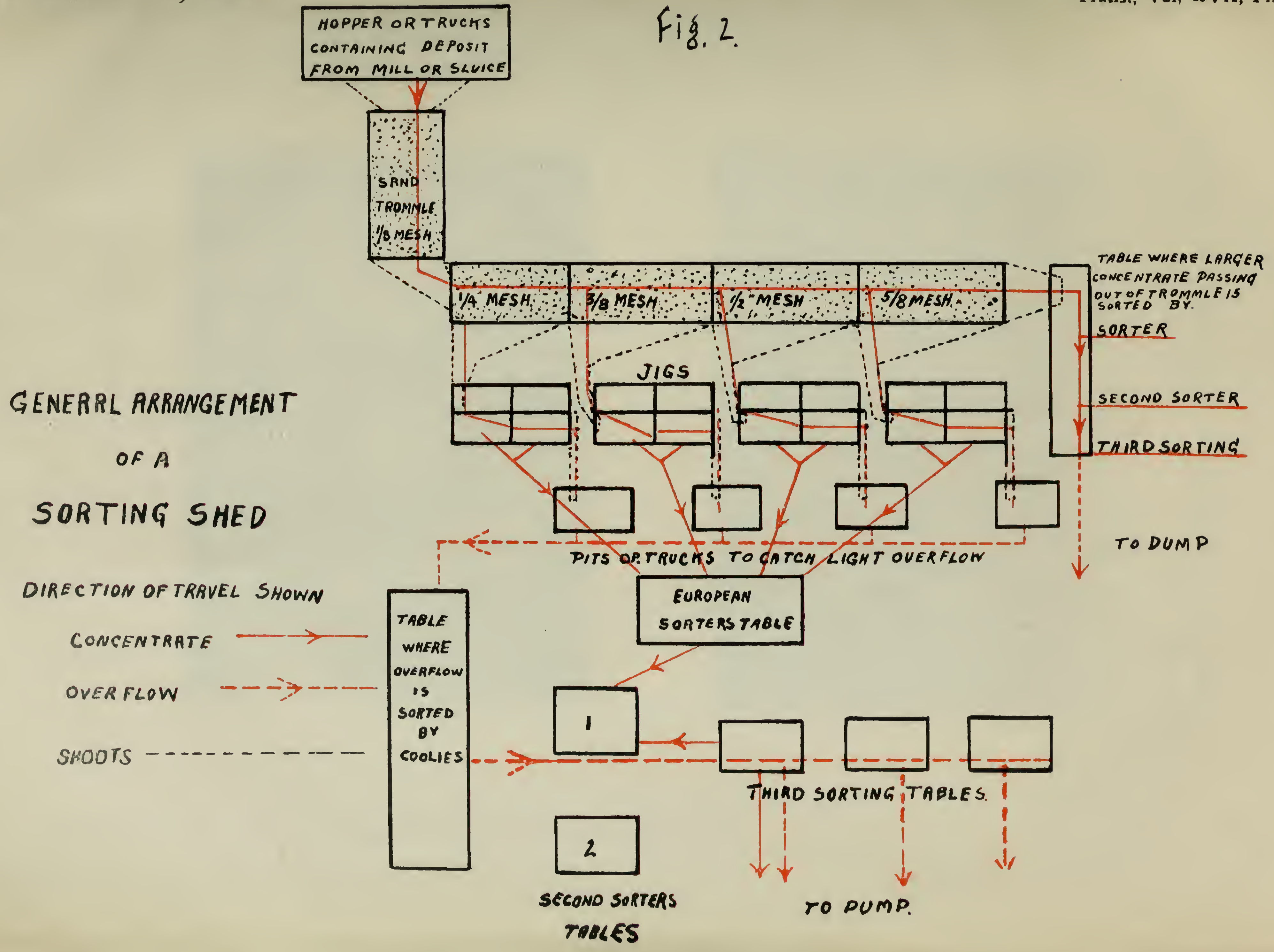

DIAGRAMMATIC SKETCH
of
SLUICING PLANT
Delivery from Gravel Pump
1st Grissley (Steel Bars 2½" to 3" apart)
2nd Grissley (Steel Plate with 1" holes)
℄ of Grissley Box
1st Sorting Table.
2nd Sorting Table
"Riffle" Boxes
Safety "Riffle" Boxes
3'-0"
2'-6"
1'-6"
1'-0"
-Riffles-
2" Piping with ¼" holes 6" apart
Water pressure 100-200 lbs/□"
Tailings

Fig. 2.


HOPPER OR TRUCKS CONTAINING DEPOSIT FROM MILL OR SLUICE
SAND TROMMLE 1/8 MESH
1/4 MESH
3/8 MESH
1/2" MESH
5/8 MESH
TABLE WHERE LARGER CONCENTRATE PASSING OUT OF TROMMLE IS SORTED BY.
SORTER
SECOND SORTER
THIRD SORTING
JIGS
TO DUMP
GENERAL ARRANGEMENT
OF A
SORTING SHED
PITS OR TRUCKS TO CATCH LIGHT OVERFLOW
EUROPEAN SORTERS TABLE
DIRECTION OF TRAVEL SHOWN
CONCENTRATE
OVERFLOW
SHOOTS
TABLE WHERE OVERFLOW IS SORTED BY COOLIES
1
2
THIRD SORTING TABLES.
SECOND SORTERS TABLES
TO PUMP.

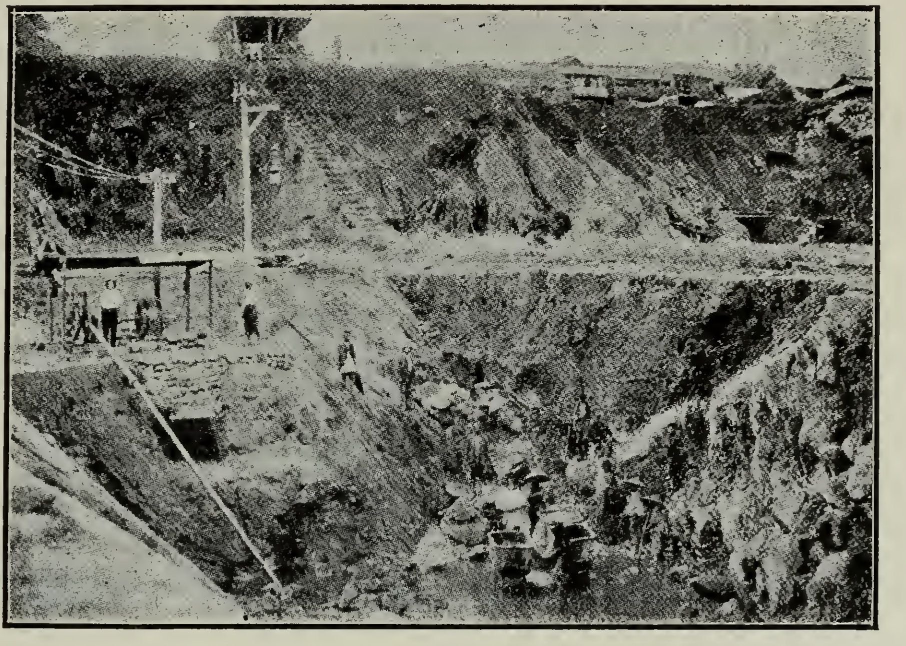


FIG. A.—A Glimpse of the Burma Mines.

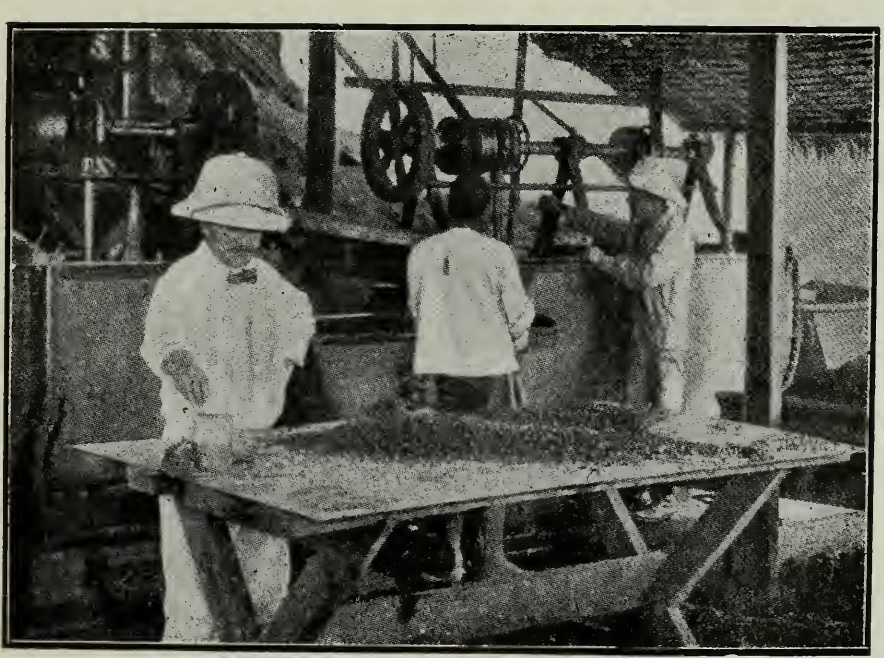


FIG. B.—Sorters at Work.

Photos taken for the Burma Ruby Mines, Ltd.]

MINING AND GEOLOGICAL INSTITUTE OF INDIA.

R. R. Simpson: Ruby Mines.

Trans., Vol. XVII, Pl. 4.

DIFFERENCES BETWEEN REAL AND ARTIFICIAL RUBIES.

STRUCTURE.	REAL STONE.	ARTIFICIAL STONE.
Bubbles ..	Irregular in shape, often elongated and frequently angular. Fig. 1.	Generally perfectly round, rarely elongated and never angular. Figs. 4, 5 & 6.
Variations of colour.	Colour frequently varies in different parts of the stone, the bands being either parallel or irregular. Fig. 2.	Colour generally uniform but occasionally varied, the bands then being curved in outline. Fig. 5.
Striations ..	Perfectly straight or angular in outline. Fig. 2.	A series of concentric curves. Fig. 5.
Inclusions of foreign matter.	Particles of various size arranged in an irregular manner. Fig. 1.	Small particles, generally arranged in curves following the lines of striation. Fig. 6.
Silk	Quite characteristic of natural ruby—due to a series of minute parallel canals arranged in three definite directions giving a silky sheen by reflected light. Fig. 3.	*This structure is never found in artificial stones.*

These differences in structure are illustrated in the plate opposite, reproduced from photo-micrographs of actual cut stones.

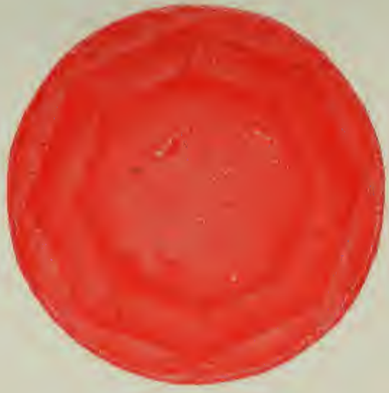


Fig. 1.

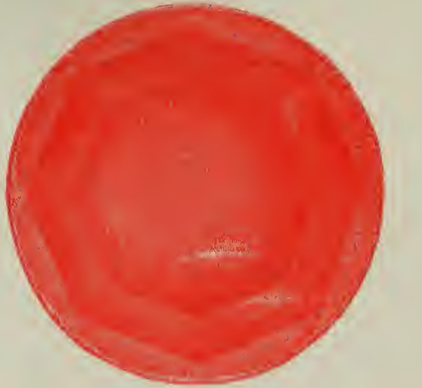


Fig. 4.

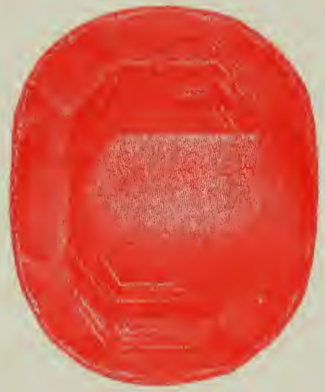


Fig. 2.

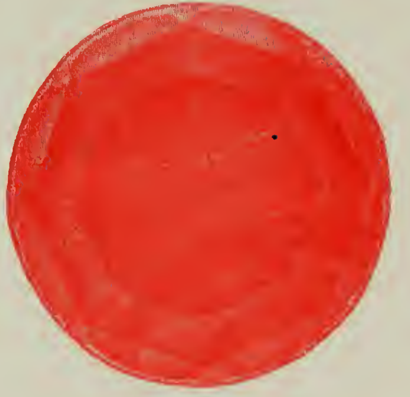


Fig. 5.

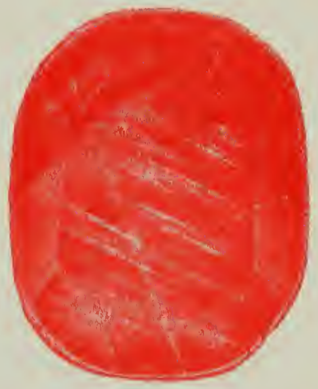


Fig. 3.

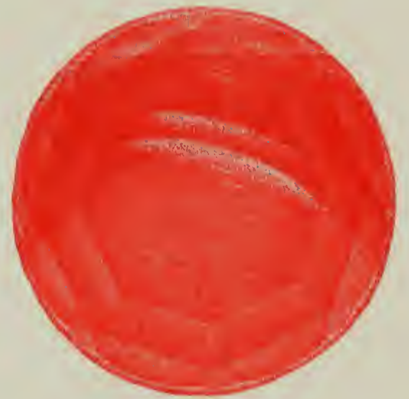
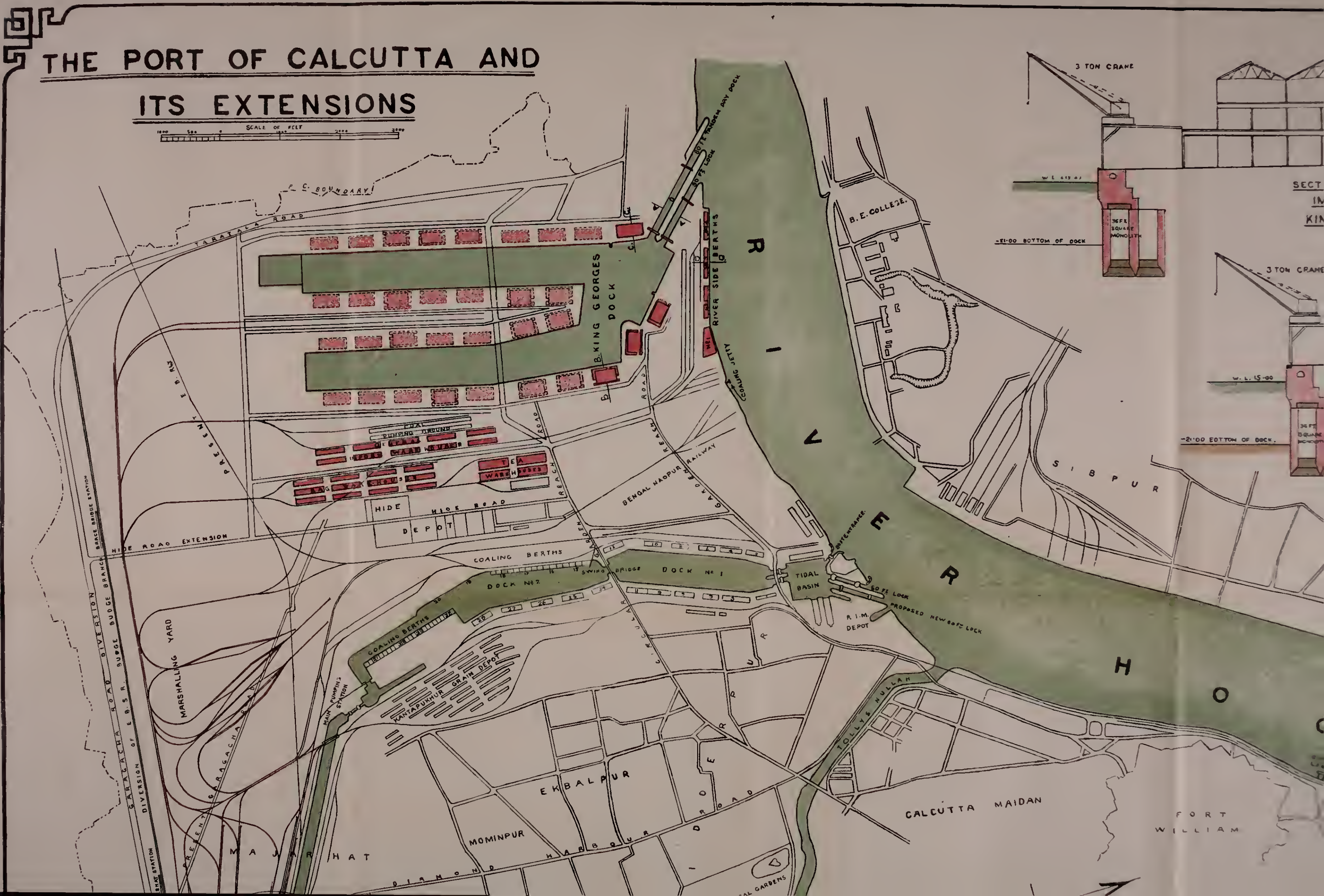
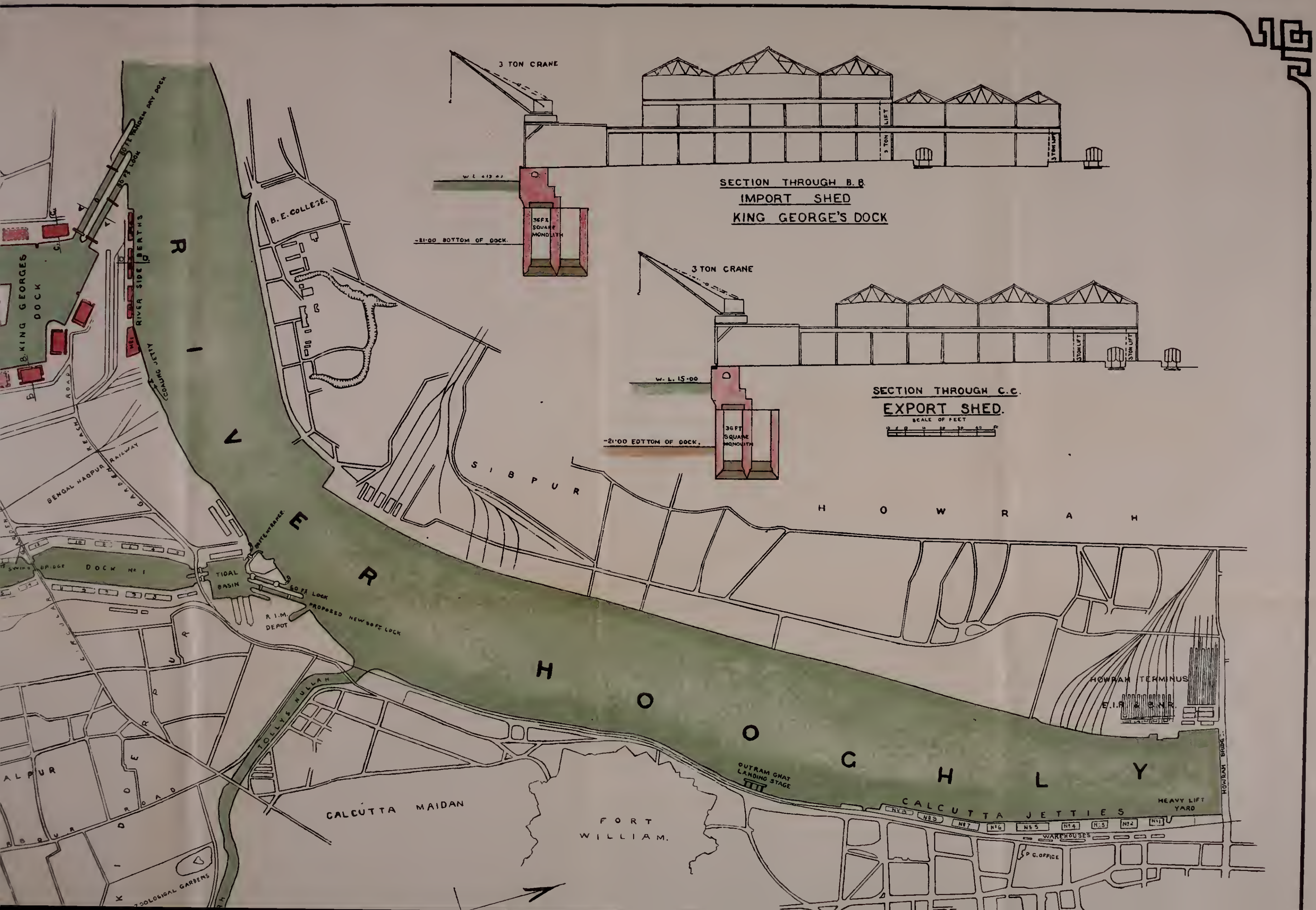
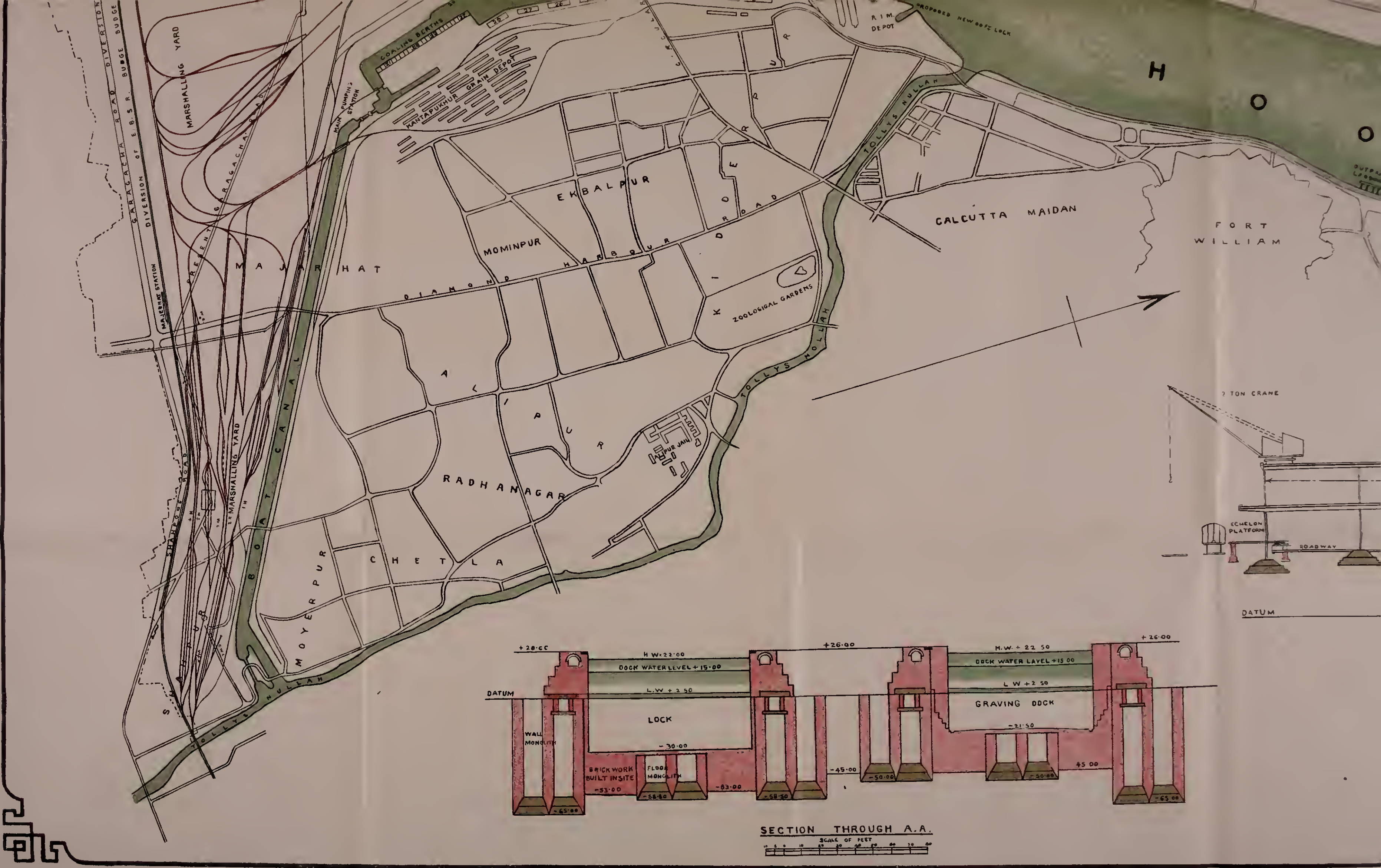


Fig. 6.

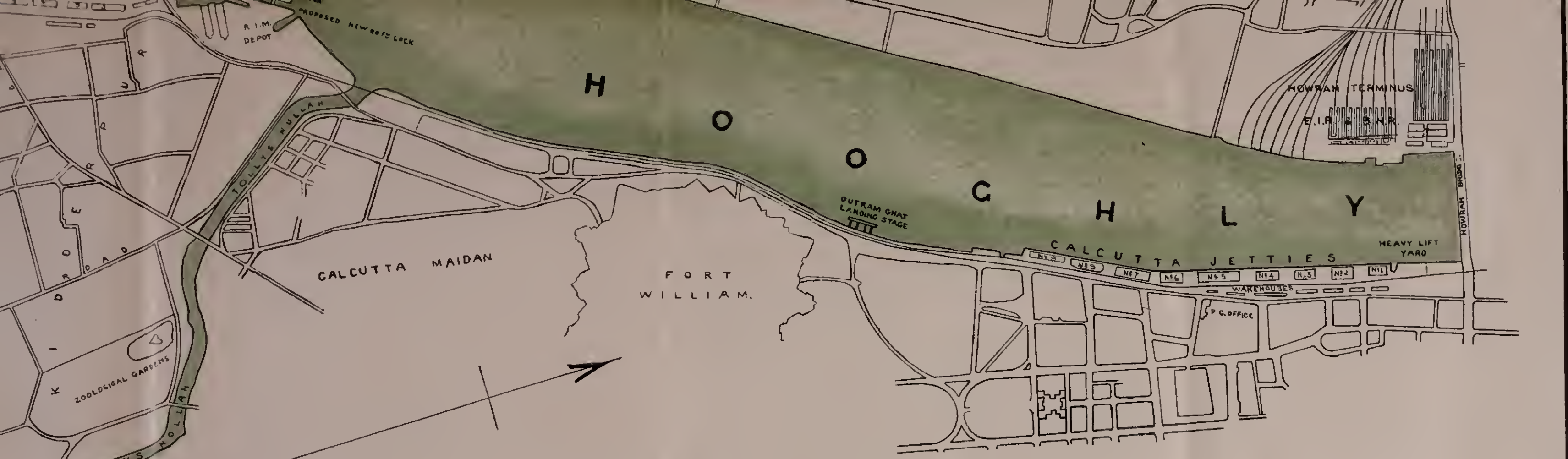
THE PORT OF CALCUTTA AND ITS EXTENSIONS

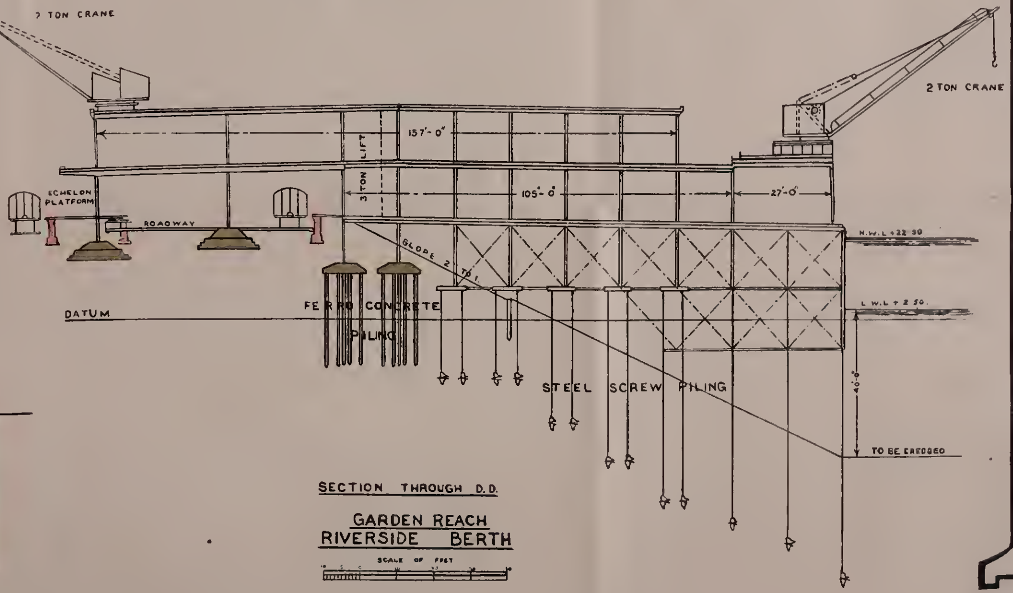



3 TON CRANE
W. L. 15·00
36 FT SQUARE MONOLITH
-21·00 BOTTOM OF DOCK.
3 TON LIFT
SECTION THROUGH B.B.
IMPORT SHED
KING GEORGE'S DOCK
3 TON CRANE
W. L. 15·00
36 FT SQUARE MONOLITH
-21·00 BOTTOM OF DOCK.
3 TON LIFT
SECTION THROUGH C.C.
EXPORT SHED.
SCALE OF FEET
60 FT TANDEM DRY DOCK
80 FT LOCK
KING GEORGES DOCK
RIVER SIDE BERTHS
COALING JETTY
B. E. COLLEGE.
RIVER HOOGHLY
SIBPUR
HOWRAH
ROAD
KEASH
BENGAL NAGPUR RAILWAY
GARDEN
SWING BRIDGE
DOCK No 1
TIDAL BASIN
BOAT ENTRANCE
60 FT LOCK
PROPOSED NEW 80 FT LOCK
R. I. M. DEPOT
CIRCULAR
GARDEN REACH ROAD
KIDDERPORE ROAD
ALIPUR
TOLLYS NULLAH
ZOOLOGICAL GARDENS
CALCUTTA MAIDAN
FORT WILLIAM.
OUTRAM GHAT LANDING STAGE
CALCUTTA JETTIES
No 1
No 2
No 3
No 4
No 5
No 6
No 7
No 8
No 9
WAREHOUSES
P. O. OFFICE
HEAVY LIFT YARD
HOWRAH TERMINUS
E. I. R. & B. N. R.
HOWRAH BRIDGE


SECTION THROUGH A.A.

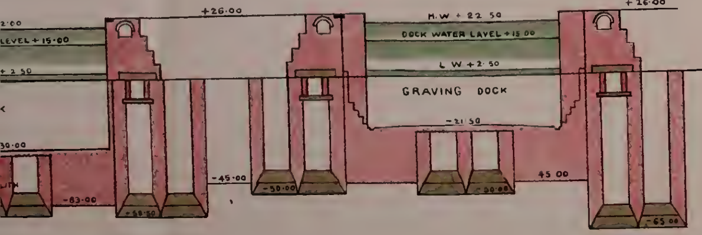
SCALE OF FEET





SECTION THROUGH D.D.

GARDEN REACH
RIVERSIDE BERTH



SECTION THROUGH A.A.

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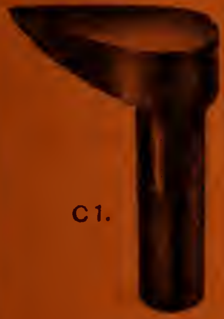
C1.

C5.

C9.

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